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THE PARASITE OF ORAL ENDAMEBIASIS, *ENDAMEBA GINGIVALIS* (GROS) *

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The pathogenic importance of the endamebae of the human mouth, which formerly were held as innocuous and were but scantily considered by pathologists, has been urged by the writers and others in a series of articles published within the past five or six months.[1] According to this view the writers regard these parasites as either directly causative of a large class of gingival and alveolar pyorrheas or as important members of a symbiotic chain with one or other of the numerous associated vegetable micro-organisms, in the production of these lesions. They find these endamebae also in the tonsils, in cases of chronic cryptal inflammation, often with tonsillar enlargement; and are disposed to regard them as concerned in the production or maintenance of such inflammatory changes of these organs; and moreover, believe that a long series of systemic complications of Riggs' disease and tonsillitis are due in some part to these parasites. Proof of the pathogenic importance of the endamebae in Riggs' disease rests upon their almost constant presence in the suppurating pockets of pyorrhea, and the prompt removal of both suppuration and of the endamebae when emetin, a proved amebicide but of low bactericidal value, is administered locally or generally. The authors hold that an overwhelmingly large group of cases of pyorrhea in which these endamebae are met should be segregated under the name "endamebic pyorrhea," in the same way that dysenteries in which dysenteric endamebae are met are known as "endamebic dysentery"; but reserve a small series of pyor-

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1. Preliminary report by Barrett: Dental Cosmos, August, 1914. See also Smith: Dental Cosmos, September, 1914. Bass and Johns: New Orleans Med. and Surg. Jour., November, 1914. Smith, Middleton and Barrett: Jour. Amer. Med. Assn., November 14, 1914. Barrett: Dental Cosmos, December, 1914. Cf. Chiavaro: Abst., Dental Cosmos, September, 1914.

rhea cases which cannot be included in this class. In attributing influence of these protozoa in the production of systemic complications the writers follow the general lines of argument as to the influence of "oral sepsis" of Hunter and others, merely emphasizing the endamebae as essentially involved because in their experience in a number of cases such complicating conditions have yielded, along with the oral lesions, to the use of emetin. Among such complications they include various chronic and recurrent arthritides (of the type of arthritis deformans), certain obscure anemias (as some of the splenic anemias and picked cases of pernicious anemia), functional and catarrhal disturbances of the gastro-intestinal canal, and probably, too, cases of degeneration of parenchymatous organs (as kidney and liver), an undefined group of serous inflammations (as of the heart), and perhaps, also, certain chronic functional nervous disturbances (neuralgias, etc.).

If no more of this comprehensive list of disturbances prove ultimately to be caused by these parasites than the local peridental suppurations and, perhaps, chronic cryptal tonsillitis, a careful systematic consideration of the parasites in question would be amply justified; and it is from this standpoint that the present discussion is presented, in an attempt to coordinate the amebiform organisms described by various observers as parasites of the human mouth and to compare them with other and better known forms of endamebae.[2]

In 1849 Gros[3] in a comprehensive article entitled "Fragments d'Helminthologie et de Physiologie microscopique," announced his discovery of an amebic parasite in the human mouth and published therewith drawings of the organism. There is little of importance, other than the announcement of the observation, in his text; but as the drawings are of importance, both are here reproduced (Fig. 1).

AMOEBEA GENGIVALIS

Au milieu des productions du tartre des dents, on voit des vibrios, une sorte de végétation qui est quelquefois très régulière; mais on n'avait pas encore mentionné les vésicules que nous avons représentées, Pl. VI, C. Ces vésicules ont un mouvement si lent et si obscur qu'il faut en être averti pour remarque qu'elles prennent toutes les formes, par une extension et contraction amoebéenne, laissent toujours voir à l'intérieur des globules qui semblent se déplacer un peu, et être l'analogue de ce que nous connaissons chez de certains infusoires soi-disant polygastriques. Leur origine, leur rôle et leur fini sont ignorés. Elles se trouvent surtout à la face interne des dents. Est-ce encore une génération spontanée?

2. This spelling is adopted by the writers instead of *entameba*, proposed by Casigrandi and Barbagallo in 1897 (*Ann. d'Igenie*, vol. 7, p. 103), because in 1879, Joseph Leidy (*Proc. Acad. Nat. Sci.*, Philadelphia, vol. 31, p. 204), then professor of anatomy in this school, proposed the generic name *endameba* for a parasitic ameba of the cockroach (*endameba blattae*). Aside from a feeling of personal loyalty to Dr. Leidy the writers are impelled by the rules of priority to adopt his nomenclature.

3. Gros: Bull. Soc. imp. de nat. de Moscow, Vol. 22, No. 2, pp. 549-573.

No one can look upon the drawings of Gros and fail to be convinced that he actually found amebae; and, if the size of the globules contained within them be accepted as that of the globular remnants of undigested leukocytic nuclei such as are commonly found in mouth endamebae, that the organisms were of about 0.025 to 0.030 mm. in diameter; that they threw out broad, rounded lobose pseudopodia and that in these pseudopods and at their bases a clear hyaline ectosarc was distinguished from a granular endosarc containing the coarse globular material. It may be accepted that these points, together with the habitat of the organisms upon the dental surface and in soft tartars were established by Gros.

In 1862, Steinberg,[4] in his thesis before the University of Kiev, in which he gives the details of his observations upon the living forms he encountered in the *substantia mollis alba* (soft tartar and refuse) about the teeth, probably refers, among other animal and vegetable organisms, to the same ameba announced by Gros thirteen years previously; but it is doubtful whether he had knowledge of the publication by Gros. At least he makes no mention of it, and writes as if under the belief that he is discussing a personally discovered amebic parasite, to which he attaches the name *amiba buccalis*.

The text is very curious but disappointing and there are no accompanying illustrations. However, because the volume containing his observations is rare in medical libraries and because of the difficulty of dealing with the original Russian language, the writers present the following translation, rendered for them by Dr. Fischelis of this city, of that part of the comprehensive article by Steinberg which concerns the matter in question:

AMIBA BUCCALIS

These organisms I met in various forms and sizes. Their characteristics are of a negative rather than of a positive character, in that they have no fixed size (this changing several times a minute); that they have no definite motile organelles (these being substituted by expansions or pseudopodia, appearing now here, now there, on different parts of the body); that they do not present a distinct direction of movement, as the pseudopodia by which they move appear at varying positions on the body and then retract again. The number of pseudopods is not fixed, now none, sometimes one, two, three, four and more; a change in the number of extensions occurring in the individual in a comparatively short time (one or two minutes). The shape of the pseudopodia in a given individual is not fixed, and their length is also variable. Granules are distributed within the body of the ameba and these do not retain any constant mutual relation, or to the individual itself or to the periphery of the ameba. I observed, however, a difference in the amebae seen on different days. While the size of the amebae in a given instance is constantly undergoing change, such change has its limitations; but it can be said that to-day, for example, the amebae observed are generally larger or smaller than those seen upon a previous day. Although the pseudopodia of a given ameba are in constant change, they

4. Steinberg: Souremenaya meditsina, Kiev, 1862, Nos. 21-24.

may in one instance be more obtuse, short and rounded off, and in another larger, less obtuse and not rounded, etc. The body of the ameba with all its variability, depending upon the instability of the pseudopods, preserves a more or less common character or peculiarity, hard to describe; but the experienced eye of the observer notices and recognizes this peculiarity. In a given ameba, for example, there are always pseudopods present; in another there are times when none are to be seen. In a word, the total summation of a series of characteristics which are individually of no importance enables the observer to conclude, for instance, that he has before him not one single type of amebae but various amebae.

Having observed amebae in the soft white substance about the teeth and those in various infusions, I was able to convince myself that with all their indefiniteness of outlines and size there are certain features characterizing all amebae, viz., all change their positions by means of their pseudopods. Following the movements of various amebae I have always noted that first on some side of the body of the organism there appears a visible thickening, at first showing as a light and almost transparent cloud; this thickening (a pseudopod) grows more and more, eventually taking on a color nearly like that of the body of the ameba and then after one-half, five, ten, twenty minutes, when it has attained a certain size and form, it remains for a time fixed, as if it were adhering to the glass and becoming hardened in that position. Then the whole body of the ameba moves toward the point where the pseudopod has become fastened and coincidently the pseudopod diminishes, even to disappearance (at least it becomes invisible to the eye of the observer). During the time of the formation of the pseudopod, particularly toward the end of that period, the granules of various size in the body of the organism move toward the side where the pseudopod was formed. Sometimes, however, pseudopods are formed simultaneously in two or three places. Then they all begin to get smaller and the body of the ameba remains in an unchanged position. Or there is but one pseudopod, and when it has attained a certain size it begins to become smaller without the body of the organism having moved. Several times I measured the rapidity with which an ameba changed position, but found that this commonly varies; but it can be said that in one minute the body travels approximately from 0.001 to 0.003 mm. The amebae which I observed in infusions traveled in the same time as a rule considerably greater distances, although their bodies are not larger than that of the ameba of my own mouth. Probably this depends on the lower consistence of the infusions, since as the fluids evaporate the amebae begin to move more slowly. All the amebae which I have encountered in the soft white substance invariably present pseudopods of rounded outline; acute forms I have never noted in these, although I have seen this last form several times in the amebae of infusions. In the amebae of the mouth as in all amebae there is a considerable amount of more or less granular material enclosed in the body. In the midst of these granules there are one or two larger than the rest (nucleus?).

It may be said from these observations (1) that I have found these amebae comparatively few times, only six times in eighty-three observations (about 70 per cent.); (2) they are more frequently found on the internal surface of the teeth than on the labial side; (3) the amebae have been found only in the lower jaw; (4) once I observed them even after very careful cleansing of the oral cavity.

The only points of positive statement in his verbose attempt to describe what he observed, are that Steinberg saw in soft tartar motile amebiform organisms, with a small number and rounded type of pseudopods, the body contrasting with the pseudopods by its granularity and containing coarser or globular bodies. One or other of the larg-

est of the latter he suspected was a nucleus. If he was correct in this surmise his *amiba buccalis* differs in its nucleus from that characterizing the ordinary examples of these mouth endamebae; if, as is probably the case, these coarse globules were merely remnants of ingesta, the nucleus in the parasites with which he was concerned was at least difficult to distinguish in the living organism. In the absence of direct statement it is worthless to speculate as to the size of his ameba. It is clear that the ectoplasm was hyaline and of a different "color" (refraction?) from the endoplasm, but there is no indication as to its proportionate amount save that it formed the pseudopods. It is of course utterly impossible to be positive because of the incompleteness of the description and the uncertainty of data; but at least the writers hold that these points are not incompatible with a belief that Steinberg's *amiba buccalis* was the same species of endameba as that now known and described more fully first by Prowazek under the same specific name.

In 1879 Grassi,[5] in a paper on parasitic protozoa, especially those of man, records (without illustrations) the finding of an ameba, which he named *amoeba dentalis,* in material obtained from gingivitis lesions. His brief text follows in the original:

4. *Amoeba dentalis* (mihi) (nell' uomo). E forse uguale alla *buccalis* di Steinberg (la memoria di quell' autore e rarissima e non potè consultarla neppure Leuckart). Ha molta somiglianse coll' *amoeba coli;* come essa al disotto dei 25° C. ò pochissimo mobile e tiene per lo più una forma tondeggiante; a 38° —40° C. è vivacissima e protea. Ne trovai numerosi esemplari in tre casi di ulite.

Later, however, although Perroncito also stated that he had observed these amebae twice in the mouth, Grassi doubted the verity of his observations, suggesting that the supposed amebae were perhaps "salivary corpuscles."[6] With our present knowledge there can be no doubt that Grassi's observation of amebae in the human mouth was correct; and the points in his brief notice that are especially noteworthy are that the parasites were obtained from cases of gingival inflammation (probably pyorrhea) and that they much resembled *ameba coli.* (This last statement, it must be remembered, was made before the present separation of the old species *a. coli* into *Endameba coli,* and *Endameba histolytica* obtained.) It is very significant, too, that by Grassi's counsel, and more or less under his direction, the dentist Chiavaro in 1914 devoted a study to *Endameba buccalis* Prowazek,[7] in which he states that "probably *Entameba buccalis*

5. Grassi: Gazzetta med. Ital.-Lomb., vol. 39 (8th series, vol. 1), p. 446; Nov. 8, 1879.

6. Grassi: Cf. Railliet, Traité de Zool., méd. et agricole, Paris, 1895, p. 118.

7. Chiavaro: v. sup. for abstract; original, Ricerche sull' Entamoeba buccalis, Lavoro eseguito nel R. Instituto di Anatomia Comparata della Università di Roma diretto dal Prof. B. Grassi, Roma, 1914.

described by Prowazek should be identified with *amoeba gingivalis* Gros (1849), with *Entameba buccalis,* Steinberg (1862), with *Amoeba dentalis* Grassi (1879) and with the ameba found by Flexner in 1892 in Baltimore in an abscess of the lower jaw." Under such circumstances there seems little reason for extended discussion, and the writers accept in full the identity of Grassi's organism with that of Prowazek.

In 1904 Prowazek[8] announced his discovery of a parasitic ameba of the human mouth, under the name of *Entamoeba buccalis,* without reference to the earlier work above detailed, and repeating for his declaredly new species a name previously appropriated by Steinberg for an organism of the same genus and of the same habitat. His article is easy of access and forms the basis for the texts of prevailing works upon animal parasitology, and is confirmed in the writings of other observers;[9] for which reasons there is no need of detailing here more than the important data included in his original article. He met these organisms in material from the cavities of decayed teeth, first in Rovigno and later in several individuals in Trieste. He describes them as varying from 0.006 to 0.032 mm. in diameter when at rest; provided with a distinct ectoplasmic border, hyaline and refractive; a granular endosarc full of food vacuoles and ingested globular masses; mononucleated (the nucleus commonly deep in the body, small, 0.0015 to 0.0045 mm. in diameter, round, vesicular, poor in chromatin, with small, deeply chromatic "binnenkörper," a thick nuclear membrane refractive and of greenish tint and often showing chromatin granules collected along its inner limit); the whole nucleus of firmer consistence than that of *Endameba histolytica* Schaudinn and not compressible by the coarse ingested masses in the endosarc; endowed with active motility; pseudopodia few, broadly lobose and rounded, but sometimes forming an elongation of the animal as a single broad pseudopod; without contractile vacuole. He speaks of the frequent presence of residua of leukocytic nuclei in the nutrition vacuoles; and describes reproduction by simple division after nuclear swelling, mitotic changes in the binnenkörper and division of the nucleus. He also calls attention to what he believes to be chromidia of nuclear origin in the cytoplasm, which he suggests may develop into complete nuclei of young amebae (which then separate from the parent by gemmation); but at time of publication he has not met evidence of reproduction encystment. He recognizes a general resemblance to *Endameba coli* (Lösch) and *Endameba histolytica* Schaudinn, but dif-

8. Prowazek: Arbeiten aus d. Kais. Gesundheitsamte, vol. 21, p. 42.

9. Cf. Leyden and Löwenthal: Charite Annalen, vol. 29, p. 3, in a case of cancer of mouth.

ferentiates it from the former by its clearer and complete hyaline ectosarc and by the differences in the observed modes of reproduction; and from the latter mainly by the greater rigidity of its nucleus and more definite structure of the nuclear membrane.

These characters in a general way the writers can corroborate, but in some points would insist upon a greater latitude of variation than the outline given above would indicate. And in fact Prowazek in his article, in commenting upon the completeness of the ectosarc, specifically indicates much variation in its thickness; and, in speaking of the rigidity of the nucleus, acknowledges that in rare instances when it is, as occasionally may be noted, in eccentric position, close to the ectosarc, it may show indentation in the varying movements of the animal. Leyden and Löwenthal[9] who identify their organisms with that described by Prowazek vary from his statements as to the size (0.008 to 0.020 mm.) of the organism, the uniformity of distinction of ectosarc and endosarc and as to the position of the nucleus (sometimes at border of endosarc and ectosarc but usually central); and they fail to recognize in the living animal the peculiar greenish shimmer mentioned by Prowazek in the nuclear membrane, suggesting the operation of the personal equation in the observation. In our earlier papers upon this subject the writers have held that of the endamebae of the various cases of pyorrhea examined all but one or two (tentatively held as *Endameba kartulisi* Döflein) were examples of *Endameba buccalis* Prowazek, but suggested that perhaps fuller study might indicate that of the larger group some should be referred to a third, unidentified species. This last point was based upon the fact that occasional examples varied beyond the usual size, attaining as much as 0.038 or 0.04 mm diameter, that these were apt to show a greater general activity of movement, and often extruded unusual numbers of pseudopods and these of unusual shapes (often small drop-like projections, or small projections of the same type upon the border of the main pseudopods). Further study has led us to believe these features are not of specific differentiating value, and as the other characters, studied in the stained specimens, are identical we are of the opinion that such forms are merely exceptional individuals of one general species. While in a given material some examples may have attained the size mentioned, the greater number were smaller; and while in a given observation a greater activity of the amoebae of a certain individual was noted, a second preparation on the same or a subsequent day from the same person has repeatedly failed to show the same degree of motility. And in one and the same ameba we have repeatedly seen alternate periods in the course of a brief observation of the living animal when the pseudopods would vary from one or two large,

rounded lobose projections, to longer and digitate types, to be succeeded perhaps in a short while by numerous small drop-like projections of the ectosarc. For such reasons we are satisfied occasional variations, even if marked, cannot be insisted upon for specific identification, and that only the common type, as the mean number, size and form of the pseudopods, should be held as of value in this connection. With this preface our description of these parasites may be outlined as follows: Naked parasitic amebae of usual diameter in resting examples of 0.030 to 0.035 mm. (with exceptional instances reaching 0.040 or slightly above); with refractile and faintly greenish-tinted hyaline ectosarc well defined from the granular endosarc, but sometimes so thin as to be easily overlooked; endosarc granular, colorless and in all but the more minute examples containing few to many digestion-vacuoles in which globular detritus of leukocytic nuclei and red blood cells are commonly found along with bacteria; with a small (0.002 to 0.005 mm.) rounded nucleus, invisible or at best uncertainly distinguishable in the unstained specimen, usually central or subcentral in position (Fig. 3; a, b), but at times eccentric (when the ingesta push it to one side) (Fig. 3; c, d, e). The difficulty of distinguishing the nucleus in the living animal prevents the writers from expressing a positive opinion as to its greater rigidity than that possessed by the nucleus of *Endameba histolytica* Schaudinn, but we have certainly met in stained specimens oval and slightly indented nuclei which makes us hesitate to accept this point which Prowazek especially indicates as distinctive from the dysentery endameba (Fig. 3; f, g, h). The nucleus is very poor in chromatic substance, vesicular, with a small "binnenkörper," sometimes showing a minute centriole, a clear space between it and the nuclear border containing no chromatin or at most a very few incomplete threads; and the border is represented by a thin but somewhat irregular line of chromatin, about which the writers are unable to recognize a further membrane and which they regard as the membrane itself. The thickness of this membrane is not absolutely fixed, sometimes more delicate, sometimes less so, but always thin, with scattered parts thicker than others or with scattered chromatin granules on its inner surface (Fig. 4). The degree of motility manifested by the parasites is to us fairly comparable to that of the dysenteric endameba (Fig. 5). The pseudopods as a rule are few (one, two, or three), usually broadly lobose and commonly attaining a maximum length of the diameter of the endosarc. Not infrequently a single extension may reach even a greater length, making the full long measurement of the parasite 70 or more micromillimeters. Or occasionally there are more pseudopods, these then small and guttulate. The pseudopods are composed practically entirely of the ectosarc, the granular endosarc terminating

at the base, or extending but a little into the larger ones. We have observed examples containing two nuclei (Fig. 3; i) and have seen binary division of the living ameba take place; and have repeatedly seen small protoplasmic masses separate by gemmation (some of these containing minute particles of chromatin); although we are uncertain as to definite chromidial formation, as we are confused by bacteria and bacterial fragments which are numerous in the larger amebae and which stain very like the chromatin with Giemsa stain and with iron-hematoxylin which we have usually used for study. We have found "dauer" cysts, but thus far no reproduction cysts.

With these data in hand the writers do not hesitate, in spite of the published differences (which we believe are due to nonspecific variations), to identify the organism with which we have become fairly familiar, with that of Prowazek. As above indicated, we see no reason to believe the *Ameba dentalis* of Grassi to be other than the same species, if we may accept identity of habitat, identity of lesion, comparable morphology (as expressed in terms of the dysenteric endameba), and the evident later opinion of Professor Grassi as to identity (inferable from his relation with Chiavaro's paper). It is impossible to be sure of Steinberg's *Amiba buccalis;* but identity cannot be denied or specifically asserted. The *Amoebea gengivalis* of Gros is so nearly like the same organism, as shown by his drawings and a few points in the text, that it is impossible to say it is not the same and quite within reason to say that it probably is identical. Gros may therefore be held as probably the original observer of the common oral endameba with which we are today familiar; and by rule of priority, with modification of spelling of *gengivalis* to *gingivalis* to conform with etymological propriety this organism should take the nomenclature *Endameba gingivalis* (Gros) instead of the more common present-day name *Entameba buccalis* Prowazek. In this attitude in fact the writers are not the first.[10]

In addition, the writers feel that further attention should be given to certain amebae which have been met by Kartulis,[11] Flexner,[12] Verdun and Bruyant[13] and Bruyant and Pelissier[14] in the same comparative lines. The first and second refer to amebae met in the pus of abscesses of the lower jaw, the third to organisms in the pus of two symmetrical abscesses of the cheeks, and the

10. Brumpt: Précis de Parasitologie, 1st and 2d editions, Paris, 1910 and 1913.

11. Kartulis: Ztschr. f. Hygiene, 1893, vol. 13, p. 9; and Kolle u. Wassermann: Handb. d. pathogen. Mikroorg., 1st ed., 1907, vol. 1, p. 356.

12. Flexner: Johns Hopkins Hosp. Bull., November, 1892, vol. 3, p. 104.

13. Verdun and Bruyant: L'Echo méd du Nord., Aug. 11, 1907, vol. 11, p. 375.

14. Bruyant and Pelissier: L'Echo méd. du Nord., June 29, 1909, vol. 13, No. 26.

fourth to amebae in pus from suppurative gingivitis. Flexner's ameba was regarded by himself as indistinguishable from the dysenteric ameba (*endameba histolytica?*), an organism apparently with no marked dis-distinctness of differentiation between the homogeneous ectosarc and the granular endosarc, the latter containing numerous vacuoles and showing in its interior red blood cells and their detritus. The nucleus was not recognized in the living cell; the pseudopods were characteristically blunt, varying from a mere bulging to a change in which the greater part of the ameba was protruded. No actual measurements were published by the observer, and no drawings accompany the text. It is usually classed as *endameba Kartulisi*. General conformity to the characters above indicated for *Endameba gingivalis* (Gros) seems to the writers, however, to be included in these incomplete data. That *Endameba gingivalis* (Gros) may be met in such maxillary abscesses the writers can testify positively on the basis of two cases. One of these occurred secondarily to alveolar fracture occurring in the extraction of a carious tooth, and was accompanied in its course of three or four years by the discharge of sequestra from the jaw and extension of the suppuration to the surrounding soft parts in the cheek and floor of the mouth, with establishment of an external fistula. At the time of discovery of the amebae in this case the fistula had healed, but sequestra were from time to time being discharged through the gingival tissues into the mouth. The mouth was kept scrupulously clean by the patient and no amebae were detected about the remaining teeth or over the exposed surface of a small sequestrum which was gradually being dislodged into the mouth; but when this was extracted numerous amebae of the ordinary *gingivalis* type were detected in spreads from its embedded surfaces. The case was treated with emetin and has promptly and completely cleared up. The second case was regarded as a dental cyst of the lower jaw, but found by the surgeon to be a chronic maxillary abscess in the pus of which the writers found large numbers of endamebae which were as a rule of larger size than usual, quite active, very commonly contained red blood cells, but on close study of stained specimens were also identified with the ameba of Gros. There seems but little reason, therefore, to regard the organisms of Flexner's case as specifically different. The impression has grown upon the writers that the ameba of Flexner became associated with that of Kartulis into an isolated species mainly because these cases of Flexner and of Kartulis were both of suppuration of the lower jaw, both published at nearly the same time and appeared before any detailed attention had been given to oral amebae, Prowazek's study not being brought forward until a decade later. Prowazek, at the close of his article above referred to, promised a further and fuller

description of his organism with differentiation from the organism of Kartulis; but the writers have failed to find this later article if it be in existence.

In 1893 Kartulis[15] announced his discovery of amebae in the pus from an abscess of the lower jaw (Fig. 6), and subsequently[16] reported similar findings in five more cases of suppurative osteomyelitis of the jaw. These organisms were named in honor of the discoverer by Döflein *Endameba kartulisi*, prior to the publication of the specific name *maxilaris*, given by Kartulis (the latter now appearing as a synonym). In all three references (*supra*) to these observations of Kartulis his first impression of similarity to the dysenteric ameba is noted. Differentiation is made because of the somewhat larger size of the organism and its higher degree of activity, both progressive and pseudopodial. In the original description, too, the nucleus is declared to be smaller and thus not comparable to the nucleus of the organism of dysentery; but it must be recalled that at the time *Endameba coli* (Lösch) was still included with the species now known as *Endameba histolytica* Schaudinn, and comparison with the larger nucleus of the former (readily observed in the unstained specimen and staining more deeply) might fairly be the cause of this statement. Kartulis describes the nucleus as small, rarely distinguishable in the unstained specimen, vesicular, and provided with an easily seen nucleolus (in stained state). It is said to be surrounded by a clear zone, referring apparently to a finely reticular perinuclear area of the endosarc. Comparing the text cuts and the colored plate illustrations of the original article by Kartulis, the diameter of the nucleus (not definitely stated) must be about 5 or 6 micromillimeters; and while in both the text cut and the colored plate it would appear to be a relatively solidly chromatic body, the "vesicular" character described indicates that the "nucleolus" is a small "binnenkörper" surrounded by a relatively clear plasm, about which a probably fairly marked nuclear wall occurs separating the intranuclear substance from the light reticular perinuclear part of the endosarc. The ectosarc is described as clearly seen in the pseudopodia, but (in the resting stage) not apparent as a peripheral zone. Both in the original text and in the cuts the pseudopods are indicated as few, large and digitate (in the later descriptions said to vary from *lobose shape* to long and comparable to the "horns" of a snail), reaching perhaps several times the length of the body diameter. If the above interpretation of the nuclear picture be correct the points of distinction from *Endameba gingivalis* (Gros) rest more particularly upon the

15. Kartulis: Ztschr. f. Hyg. u. Infectionskr., vol. 13, p. 9.

16. Kartulis: Centralbl. f. Bakt. u. Parasitenk. 1 Abt., Ref., vol. 33, p. 471; 1 Panhellen. Med. Congress in Athens, May 6-11, 1901; see also Kolle u. Wassermann, Handb. d. pathogen. Mikroorg., 1st ed., vol. 1, 1907, p. 356.

EXPLANATION OF PLATE

Fig. 1.—Photographic reproduction of that portion of the plate of illustrations accompanying article by Gros in 1849, which depicts his *Amoebea gengivalis*.

Fig. 2.—Photographic reproduction of part of plate illustrating article by v. Leyden and Löwenthal upon *Endameba buccalis* Prowazek, showing organisms in motion.

Fig. 3.—Camera lucida drawings of *Endameba gingivalis* (Gros), stained with iron hematoxylin; *a* and *b* showing the usual central or subcentral position of the nucleus; *c, d* and *e*, examples with the nucleus in eccentric position; *f, g* and *h*, examples showing nucleus in compressed condition; *i*, an example with two nuclei (it is suspected, although not known, that the small ameba lying within the same space in the stained film had been recently separated from the larger one.)

Fig. 4.—Photomicrograph of *Endameba gingivalis* (Gros), stained with iron hematoxylin; from material from pyorrhea pocket.

Fig. 5.—Composite outlines of moving *Endameba gingivalis* (Gros), including five camera lucida sketches; time included, twenty seconds; to show activity of movement and long type of pseudopod at times assumed; magnification as in Figure 3.

Fig. 6.—Photographic reproduction of a text cut of *Endameba kartulisi* Döflein from original article by Kartulis in 1894.

Fig. 7.—Photographic reproduction of text cut illustrating article in 1907 by Verdun and Bruyant, showing *Endameba pyogenes* Verdun and Bruyant.

Fig. 8.—Photographic reproduction of cut of endameba described by Ribbert, here shown in parotid duct.

Fig. 9.—*Endameba mortinatalium* Smith and Weidman, in minute hepatic abscess; stained with iron-hematoxylin.

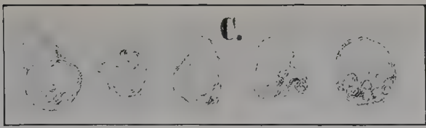

Fig. 1

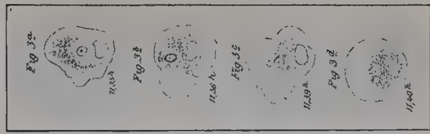

Fig. 2

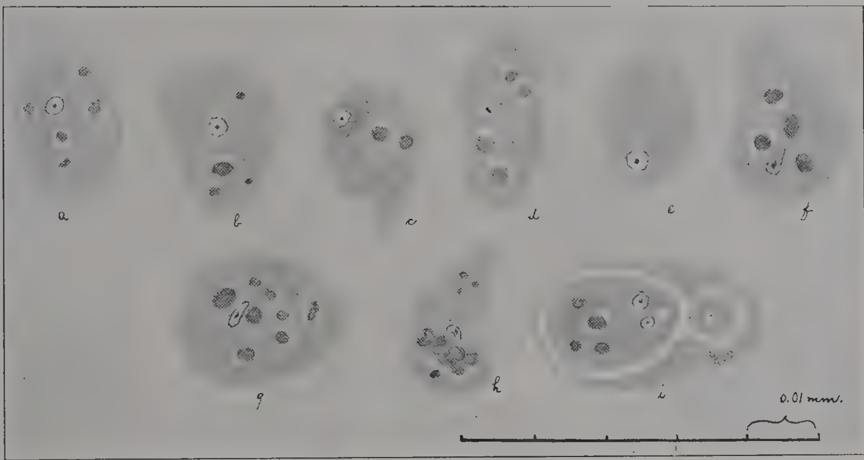

Fig. 3

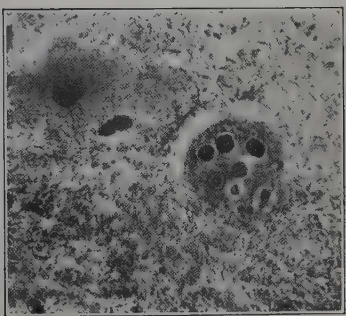

Fig. 4

Fig. 5

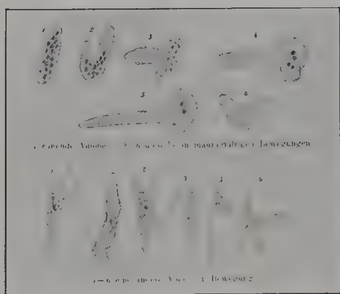

Fig. 6

Fig. 7

Fig. 8

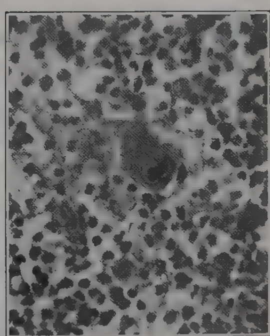

Fig. 9

size of the organism, the size and shape of the pseudopodia, the activity of movement and the lack of a clear ectosarcous border—in all of which particulars nonspecific variations of at least comparable degree may occur. Certainly in the occasional organisms which we have in the living state suspected of showing the characters of the ameba of Kartulis because of these latter points, the writers have seen the individual change and assume the general features of *Endameba gingivalis* (Gros), and subsequent study of stained examples has led us to conclude identity with the latter. We are of opinion, therefore, that there is not sufficient basis for accepting the specificity of Kartulis' type of these amebae, and would refer it also to the species *gingivalis* of Gros.

There remains of this group of parasitic amebae of the mouth for comparison the organism known as *Endameba pyogenes* of Verdun and Bruyant,[17] studied by these writers in the pus from two symmetrical abscesses of the cheeks in a case under the surgical care of Dubar and Leroy, in which there had preceded the abscesses carious teeth and pyorrhea lesions, to which the clinicians were disposed to attribute the abscess development (Fig. 7). Later Bruyant and Pelissier[18] mention the discovery of similar amebae in two cases of gingival suppuration, but with no more than partial description refer for their characters to the original article by Verdun and Bruyant. The mean diameter of these parasites is given as from 0.03 to 0.035 mm. They are described as quite active in movement, with large rounded pseudopodia rapidly projected and retracted. The pseudopods are hyaline in appearance, the endosarc granular; the ectosarcous border is not clearly seen, being absent or only visible in the pseudopods and their immediate bases. The endosarc is commonly full of digestive vacuoles in which remnants of erythrocytes and leukocytes are to be detected. The nucleus is described as relatively large, from 0.008 to 0.015 mm. (from one third to one half the diameter of the resting ameba), always visible, granular but paler than the surrounding endosarc. Double contoured cysts, from 0.006 to 0.015 mm., are described and said to frequently contain multiple, but never more than four, nuclei. Larger cysts, with single wall and a single unchanged nucleus are described, and perhaps are resistance encystments. Stained with Borrel blue and eosin, the body of the ameba is light blue, the nucleus (distinguished from the deeper blue remnants of leukocytic nuclei and copper-red residua of red blood cells about it) is apparently stained diffusely a reddish violet tint; is granular and often shows a well-defined nucleolus (binnenkörper). In brief, the size of the nucleus, its richness in chromatin

17. Verdun and Bruyant: L'Echo méd. du Nord., Aug. 11, 1907, vol. 11, p. 375.

18. Bruyant and Pelissier: L'Echo méd. du Nord., June 27, 1909, vol. 13, No. 26.

and its visibility in unstained specimens, along with the mode of reproduction within a cyst, mark this as a species of these mouth amebae distinctly different from those hitherto discussed in this paper; and as such it must be kept clearly in mind in studies of oral endamebiasis.

It is impossible to come to a definite conclusion as to the relationship of this last organism with certain other endamebae which have been described from the human body which contain large and richly chromatic nuclei because of the deficiency of data on both sides, but it may be suggested that in this connection there should be remembered certain organisms described by Smith and Weidman[19] under the name *Endameba mortinatalium,* being found by them in small abscesses in the liver and kidneys and also in the lungs of a still-born fetus (non-syphilitic). This these writers identify in a later note (October, 1910) with unnamed organisms met by Jesionek and Kiolemengolou[20] in the kidneys, liver and lungs of a syphilitic eight months fetus, and also by Ribbert[21] in the renal tubules of a syphilitic new-born infant twenty years before his publication, and twice thereafter in the parotids of nonsyphilitic infants (Fig. 8). Tietze[22] also records the discovery of amebiform organisms in a parotid tumor in a child of about 4 years of age; but these were held by Schaudinn, who examined histological sections, to be either identical to or akin to Prowazek's endameba. Smith and Weidman[23] have recently encountered the same large-nucleated ameba in the lungs of a congenitally syphilitic baby. These organisms (Fig. 9) in fixed and stained state, for the most part measured 0.025 to 0.032 mm. in diameter; the nucleus spherical or oval and usually from one third to one half the cell diameter. Considerable variation exists in the amount of ectosarc, which however in some examples is seen as a complete clear border zone in the stained examples. The endoplasm is highly granular, containing at times red blood cells and leukocytic detritus, and in some instances is full of chromidia-like bodies. The nucleus contains a very large, granular and richly chromatic binnerkörper, occasionally showing a centriole; about the binnenkörper a narrow clear zone of nuclearplasm and a delicate chromatin-staining nuclear wall, with threads or grains of chromatin scattered in the clear zone. Pseudopodia few and rounded in the stained specimens. The occurrence of these organisms in the parotid and their general comparability suggest that further study of relation be made.

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19. Smith and Weidman: Univ. of Penna. Med. Bull., September, 1910.
20. Jesionek and Kiolemengolou: München. med. Wchnschr., 1904, No. 43.
21. Ribbert: Centralbl. f. allgem. Pathol., 1904, vol. 15, p. 945.
22. Tietze: Mittheilung. aus d. Grenzgebiet. d. Med. u. Chir., 1905, vol. 15, p. 303.
23. Smith and Weidman: Am. Jour. Trop. Med., vol. 2, p. 256, October, 1914.

Finally the writers (with natural hesitation because of full appreciation of the resultant confusion in our current views as to the relations of endamebae to dysentery and the impossibility of satisfactorily explaining a great field in the etiology and pathology of endamebic dysentery and its immediate complications as the liver abscess, if this statement be thought worthy of consideration) feel constrained to acknowledge that from a purely morphological standpoint we are unable to differentiate the organism which we believe to represent the vast majority of oral endamebae and to occur in an extremely large number of persons not merely in the tropics but all over the world, from *Endameba histolytica* Schaudinn. We are unwilling to make any assertion which involves biological identity in full, merely asserting that the morphological similarity is so close that we feel unable to make a distinction from microscopic observation alone. The limits of size of the two organisms are too close to permit this to serve as a specific difference; in both (Fig. 3; a, b, c, d, e) there is a tendency to clear ectosarcous differentiation from the granular endosarc in which cellular detritus and especially red blood cells and their debris may be seen; in both there is a small nucleus (the position of which is not fixed for either) of vesicular type, poor in chromatin, practically invisible in the unstained specimen, and showing the same small binnenkörper, the same plasmatic space between the latter and the nuclear border, which is formed by a delicate but variably irregular and chromatic nuclear membrane; both show few pseudopodia characteristically, and these usually of broad lobose type; and the general type of motility of both the cell and the pseudopods is closely comparable in the main but variable in both. Both forms, too, divide by binary fission and by gemmation,[24] both fail to form reproduction cysts as far as is known. And if it be a characteristic of *Endameba histolytica* Schaudinn to destroy red blood cells, so, too, is *Endameba gingivalis* (Gros) capable of rapid digestion of these same elements. We have repeatedly watched the complete disappearance of freshly englobed erythrocytes in the living ameba of Gros, the red cell fading before our eyes to invisibility in from three to five minutes.

Prowazek in his original article compares his ameba, which we have above held to be identical with *Endameba gingivalis* (Gros) with

24. *Note by Editor:* Gemmation, as a form of division in *E. hystolytica,* has been proved not to occur, the so-called gemmation being due to degenerative changes. In *E. histolytica* reproduction cysts occur, of course; the four-nucleated cyst of this species being easily distinguished from the eight-nucleated cyst of the harmless *E. coli.* If it be true that reproduction cysts do not occur in *E. gingivalis,* this alone would serve to distinguish this species from *E. histolytica.* Likewise the *tetragena* type of nucleus of *E. histolytica* does not occur, according to the author's description, in *E. gingivalis.*

Endameba histolytica Schaudinn, acknowledging its close conformity, but differentiating it by the point that its nucleus is more rigid, less likely to present compressed, flattened outlines. Such a point is exceedingly questionable; nuclear deformation may depend as much upon the amount and rigidity of ingested substances and the movement pressure of the cell as upon any special nuclear consistence. Prowazek from his text gives the impression that this is best appreciated in the living and moving organism; but it is difficult to observe the nucleus of either one in this state. Occasionally at least the writers have met slightly indented and oval nuclei in stained specimens of *Endameba gingivalis* (Gros).

Even if this suggestion be refused, the writers feel there is need of a more easily demonstrable differentiation, and believe that more than merely morphological studies are requisite to prove the dual specificity.

ACANTHOCEPHALA IN NORTH AMERICAN AMPHIBIA *

H. J. Van Cleave

A careful search of the literature has revealed but a single instance in which Acanthocephala have been found parasitic in North American Amphibia. Stiles and Hassall (p. 352) record the occurrence of Acanthocephala in *Diemyctylus viridescens,* Raf. taken in Maryland by Dr. Hassall, though no determination of the species is given in the work cited. Through the courtesy of Dr. B. H. Ransom of the U. S. Bureau of Animal Industry the writer has been permitted to study these undetermined forms. The label accompanying this collection of seven worms bears the additional information that the host was taken at Franklin Falls, Baltimore, Md., in May, 1893, and that they were from the intestine. The location of the brain (Fig. 1) at the base of proboscis sheath, together with the fact that the retinacula proceed directly from the posterior end of the sheath give sufficient data for ascribing these specimens to the genus *Acanthocephalus* Koelr. Further the writer has determined them as belonging to the species *A. ranae* (Schrank).

The recent work of Lühe (1912) upon variability in the number of proboscis hooks in this species has led the writer to make a study of this point in the material at hand. In forty-three specimens collected from the same locality Lühe found the number of longitudinal rows of hooks varied from thirteen to nineteen (1912, p. 297), while the number of hooks in each row varied within the limits of four and six. Some individuals had rows of four hooks alternating with rows of five, some had five in each row, some had rows of five hooks alternating with rows of six hooks, while still others had six hooks in each row. Of the seven individuals of the American form which the writer has studied, four have the proboscis fully protruded. In every one of these the proboscis is armed with twelve rows of hooks and there are six or seven hooks in each row. These numbers agree precisely with the data given by Porta (1908, p. 228) for the hooks of *A. ranae* (Schrank). Unfortunately Porta does not give measurements for the hooks of the form he described under this name. He describes the embryos as being 0.07 to 0.09 mm. in length while Lühe (1911) records a length of 0.11 mm. and

* Contributions from the Zoological Laboratory of the University of Illinois, under the direction of Henry B. Ward, Urbana, Ill., No. 45.

a breadth of 0.013 mm. for embryos of *A. ranae* from Germany. If the two authors are describing the same species there is far greater range of variability in the size of the embryos of this species than has come to the attention of the writer in a study of embryos of many species of Acanthocephala from the United States.

A comparison of hook lengths in the American form with Lühe's data for *A. ranae* from Germany is given here, following Lühe's method of designating each hook. Since the hooks in two adjoining longitudinal rows alternate, those in the longest row are numbered from the tip posteriad: 1, 3, 5, 7, etc., while the hooks in the adjacent row are: 2, 4, 6, 8, etc. Lühe's measurements are for but a single row.

Hook Lengths in Acanthocephalus Ranae (Schrank)

Hook	American Form	German Form Data from Lühe
1	59μ	60μ
2	71	..
3	71	70
4	71	..
5	71	75
6	77	..
7	77	80
8	77	..
9	77	75
10	71	..
11	71	50
12	53	..
13	30	—

Attention should be called to the fact that in representatives of this species found in North America the basal hooks in some rows are very much shorter than the basal hooks in the row adjoining (cf. 12 and 13 above).

Inasmuch as Lühe has found such great variability in numbers of hooks in *Acanthocephalus ranae* it is not beyond reason to expect that in his relatively small number of individuals (43) he did not include the full range of variability. The writer supports Porta's record of twelve longitudinal rows of hooks. The depression of Lühe's lower range of variability for number of longitudinal rows of hooks by one, and the extension of his upper range of the number of hooks in each of these rows similarly by one, are thus within the bounds of variability in this species. It was in view of these facts that the writer found it necessary to ascribe the specimens of the single North American collection of Amphibian Acanthocephala to the species *Acanthocephalus ranae* (Schrank). Unfortunately none of the specimens contained fully formed embryos. For that reason measurements of embryos had to be omitted from the all too few

sources of data of value in the determination of species in the Acanthocephala.

The fact that there has been but one published record of Acanthocephala in Amphibia of North America led the writer into an investigation to determine whether this might be due to inadequate study and records of Amphibian parasites in this country or to a comparatively infrequent infestation of Amphibians with parasites of this class. The writer, personally, has records of the examination of over one hundred fifty Amphibia for parasites, chiefly from Illinois, none of which harbored Acanthocephala. The records of Leidy's extensive researches in parasitology, while including many references to other forms parasitic in Amphibia, contain no mention of Acanthocephala in that group. Dr. H. B. Ward has very kindly granted permission to include results of the examination of about fifty Amphibia contained in the records of his parasitological col-

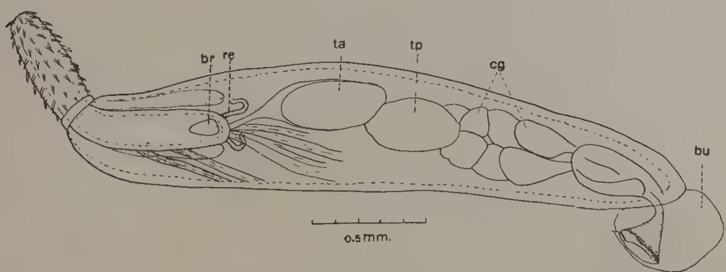

Fig. 1.—Acanthocephalus ranae (Schrank). Toto mount ♂. Stain, Ehrlich's Acid Hematoxylin. Damar mount; br, Brain; re, Retinacula; ta, Anterior testis; tp, Posterior testis; cg, Cement glands; bu, Copulatory bursa.

lection. His materials represented collections from seven different states in the central and western United States. His records indicate the absence of Acanthocephala in all Amphibia examined. The writer is also indebted to Dr. George R. La Rue who very kindly furnished data from the records of his collections. In over one hundred and thirty hosts, including numerous species both of Urodela and of Anura from six different states, including eastern, central, and western states, La Rue found no Acanthocephala. From all sources, then, the writer has data showing the absence of Acanthocephala in above three hundred specimens of Amphibia distributed in the following states: Illinois, Michigan, Kansas, Nebraska, Ohio, Pennsylvania, North Dakota, Oklahoma, and Missouri. Such a condition stands in marked contrast to the records of European investigators who have recorded several species of Acanthocephala from Amphibia with many cases showing high percentages of infestation. Thus, for

example, Mühling (p. 55) found 50 per cent. of *Rana esculenta* infested with *A. ranae* (= *E. haeruca*). European Amphibia also serve as intermediate hosts for larval Acanthocephala which attain maturity in the intestine of birds. *Corynosoma semerme* and *Centrorhynchus aluconis* both pass their larval stage in European Amphibia. So far no larval Acanthocephala are known in North American Amphibia.

REFERENCES CITED

Leidy, Joseph, Jr. Researches in Helminthology and Parasitology. Smithsonian Misc. Coll., 1904, 46: 1-281.

Lühe, M. Die Süsswasserfauna Deutschlands. Heft 16, Acanthocephalen. Jena; 1911, p. 116; Zur Kenntnis der Acanthocephalen. Zool. Jahrb., 1912, Suppl. 15; Bd. 1: 271-306; 2 pl.

Mühling, P. Die Helminthen-Fauna der Wirbeltiere Ostpreussens. Arch. Naturg., 1898, 1: 1-118; 4 pl.

Porta, A. Gli Acantocefali degli Anfibii e dei Rettili. Arch. Zool., 1908, 3: 225-259; 1 pl.

Stiles, C. W., and Hassall, A.: A preliminary catalogue of the parasites contained in the collections of the United States Bureau of Animal Industry, United States Army Medical Museum, Biological Department of the University of Pennsylvania (Coll. Leidy) and in Coll. Stiles and Coll. Hassall. Vet. Mag., 1894, Phila. 1: 245-253, 331-354.

THE PROTECTION OF PARASITES IN THE DIGESTIVE TRACT AGAINST THE ACTION OF THE DIGESTIVE ENZYMES

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In carrying out an investigation on the rate of oxidation of enzymes and their corresponding pro-enzymes it has been necessary to make use of many dogs for collecting pancreatic juice and preparing secretin and enterokinase. Tapeworms and roundworms were found in the intestines of many of these animals and the question so often raised presented itself, viz., why is it that these worms are not digested by the trypsin? Various explanations have been offered in answer to this question, such as the existence of an antisubstance in the worm which inhibits the action of the trypsin, or the resistance of the cuticle to the activity of the enzyme or the fact that the parasites are alive, etc. Lillie and others have shown that the mucosa of the stomach and intestine possesses intense oxidative properties and Burge has found that trypsin, in common with all the digestive enzymes, is relatively easy to oxidize. On the basis of these two facts we have advanced an hypothesis according to which the mucosa of the digestive tract by means of the oxidative processes going on in its cells is able to maintain its integrity during life by rendering inactive the enzyme solution immediately in contact with it. This assumes that there are two opposing activities at work, viz., the active enzyme within the lumen of the digestive tract attempting as it were to digest the cells of the mucosa, while the oxidative processes of these cells are rendering the enzyme inactive and hence protecting the mucosa from digestion. The same explanation might be given for the fact that parasites are able to live in the intestinal juices without being digested. The assumption is that the oxidative processes going on in the cells of the parasite exposed to the action of the trypsin are oxidizing the enzyme. Thus the parasite, like the mucosa of the tract itself, is protected from digestion.

The following experiments and observations were made to determine if any experimental evidence could be brought forward in support of this assumption:

A dog was etherized and killed with chloroform. The intestine of this animal was slit open and the tapeworms and roundworms removed. The duodenum and several inches of the intestine following were thoroughly washed and the mucosa gently scraped with the handle of a scalpel. Enterokinase was prepared by extracting this scraping with 0.7 per cent. sodium chlorid. The

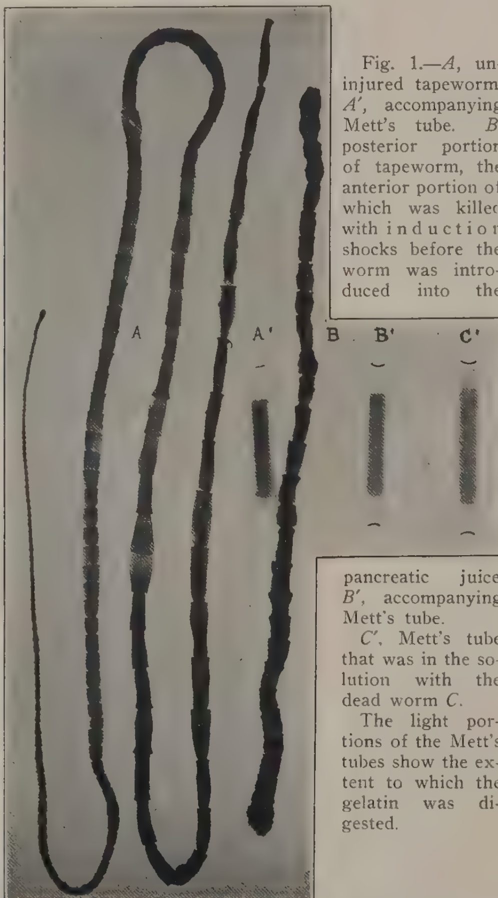

Fig. 1.—*A*, uninjured tapeworm. *A′*, accompanying Mett's tube. *B*, posterior portion of tapeworm, the anterior portion of which was killed with induction shocks before the worm was introduced into the pancreatic juice. *B′*, accompanying Mett's tube.

C′, Mett's tube that was in the solution with the dead worm *C*.

The light portions of the Mett's tubes show the extent to which the gelatin was digested.

secretin was prepared by extracting the hashed mucosa with 200 c.c. of 0.4 per cent. hydrochloric acid. This extract was boiled and neutralized while boiling with 1 per cent. sodium hydroxid. On filtering a perfectly clear solution was obtained. This secretin was injected into the jugular vein of an etherized dog and approximately 100 c.c. of clear pancreatic juice were obtained from the pancreatic duct.

Thirty c.c. of this pancreatic juice were activated by the addition of 3 c.c. of enterokinase. This trypsin solution was sterilized by exposing it for five minutes to the radiation from a 2,400 candle power quartz mercury vapor burner at a distance of 12 cm. A tapeworm, *Taenia serrata,* about 40 cm. in length, was washed in tap water, rinsed in distilled water, and introduced into 10 c.c. of the solution. Another tapeworm of about the same size was selected and one electrode from the secondary of a large induction coil was placed near its anterior end while the other electrode was moved back and forth over the anterior half of the parasite until no response to stimulation was obtained from this portion. In this manner the anterior part of the tapeworm was killed without breaking the cuticle. A third worm of similar size was selected and the entire worm killed by means of induction shocks. These worms were placed in vessels containing 10 c.c. of the activated pancreatic juice. The three vessels containing the worms were allowed to stand at room temperature for twelve

Fig. 2.—*A,* uninjured roundworm. *B* and *C,* undigested halves of two worms, the dead halves having been digested.

hours. At the end of this time the uninjured worm and the uninjured half of the other worm were stimulated by means of weak induction shocks. It was found that they were alive. These solutions were removed and 10 c.c. of fresh sterilized juice introduced into each vessel. At the end of the second twelve-hour period the anterior portion, which had been killed with induction shocks, as well as the entire worm which had been killed in the same manner had begun to be digested. After introducing into each vessel 10 c.c. of fresh juice the worms were permitted to stand for a third twelve-hour period. Thus the parasites were exposed to the action of the trypsin for thirty-six hours. Figure 1 shows the condition of the parasites at this time. *A* is the uninjured tapeworm; *A′*, a Mett's tube containing gelatin colored with Congo red which was placed simultaneously with the worm in the pancreatic juice in order to give an idea of the strength of the trypsin. The dark portion of the tube represents

the undigested gelatin and the light the empty tube from which the gelatin was digested. *B* is the worm the anterior part of which was killed with induction shocks, *B'*, its accompanying Mett's tube. *C'* is the tube which was in the solution with the dead worm *C*. It may be seen that no portion of the normal worm *A* was digested, that the dead portion of *B* was completely digested as was also the dead worm *C*.

Similar experiments were carried out using roundworms. Halves of roundworms were killed by means of induction shocks and these together with an uninjured worm were introduced into 15 c.c. of activated pancreatic juice, sterilized by ultra violet. The vessel containing the juice and the worms was placed in a thermostat at 38 C. At the end of ten hours the solution was replaced by 15 c.c. of fresh juice. At this time digestion of the dead portions had begun. The uninjured worm and the uninjured portions of the other two were still alive. At the end of the second ten-hour period the dead portions of the worms were almost completely digested. The juice was again changed and at the end of the third ten-hour period the uninjured portions were completely digested. A photograph of the worms was taken at this time (Figure 2); *A*, is the uninjured worm; *B* and *C*, the undigested halves of the two worms, the dead halves having been digested.

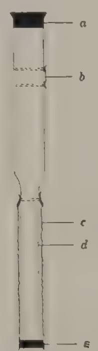

Fig. 3.—*a*, pipette closed with stopper; *b*, oneway valve; *c*, segment of round worm; *d*, platinum mesh; *e*, thin rubber and ligature.

The experiments now to be described were devised to show that the uninjured parts as well as the uninjured worms were not digested because of the protection afforded by the oxidative processes going on in them. Two segments, each 5 cm. in length, were cut from a roundworm. Into the lumen of one segment (Fig. 3, *c*) was introduced a cylindrical piece of platinum mesh (*d*) previously covered with platinum black. Around one end of the segment was wrapped a narrow strip of thin rubber (*e*) about which a ligature was tied thus closing this end of the segment. A pipette (*a*) was inserted into the open end. This was held in position by means of a ligature. The segment was filled with hydrogen peroxid through the pipette, the pipette stoppered and a one-way escape valve (*b*) arranged so that the oxygen liberated from the hydrogen peroxid by platinum black could not escape from the segment through the pipette until the pressure reached approximately 25 mm. of mercury. The pressure arising from the liberated oxygen forced it through the body wall of the roundworm. In this manner all parts of the roundworm were exposed to oxygen presumably in a nascent state. At this stage of the experiment the segment of the worm was dead and the only processes going on within it in

any way comparable to any of the living processes, was the artificial oxidative process. One end of the other segment cut from the same roundworm was ligatured and the segment filled with a solution made by decomposing hydrogen peroxid with platinum black. The other end was closed by a ligature and the preparation introduced into the activated pancreatic juice along with the other preparation. The vessel containing the preparations was placed in a thermostat at 38 C. and allowed to remain for forty-eight hours. At intervals of two hours fresh hydrogen peroxid was introduced into the segment into which the pipette was tied. At the end of twenty-four hours the pancreatic juice was removed from the vessel and fresh pancreatic juice added. At the end of forty-eight hours there was very little if any indication of digestion in the segment which was permeated by oxygen while the other segment was digested. The conclusion is drawn that nascent oxygen prevented the segment of the worm from being digested by rendering inactive the enzyme solution in contact with it.

SUMMARY

Tapeworms and roundworms from the intestine of the dog are not digested when introduced into activated pancreatic juice so long as they remain alive but are digested when dead. If any part of them be killed this part is digested.

A dead roundworm which is ordinarily digested when introduced into activated pancreatic juice, can be prevented from being digested by keeping the dead body wall constantly permeated with nascent oxygen.

The oxidative processes of the living parasites enable them to withstand the action of the digestive juices by oxidizing the enzyme solution immediately in contact with them.

LITERATURE CITED

Lillie, R. S.: On the Oxidative Properties of the Cell-Nucleus. Amer. Jour. Physiol., 1902, 7, 412-421.

Burge, W. E., and E. L.: The Rôle of Nascent Oxygen in Regulating the Activities of Enzymes in Animals and Plants. Amer. Jour. Physiol., 1914, 34, 140-148.

PARASITES OF THE AMERICAN MUSKRAT (*FIBER ZIBETHICUS*) *

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In previous papers[1] the finding of a varied and abundant parasitic fauna in muskrats in Nebraska was announced, and attention was called to the fact that with the exception of a brief note by Leidy[2] there are no references to or descriptions of the parasites of the muskrat. Those papers reported the finding of seven new species of trematodes, one new species of cestode, and two new species of nematodes. In more recent investigations, two additional species of trematodes, one species of cestode and one species of nematode have been found.

A recent appeal to American helminthologists in the Journal of Parasitology by Prof. Al. Mrazek further emphasizes the lack of information concerning the parasites of the muskrat and the desirability of more extensive data. For these reasons it has seemed advisable to publish at once this preliminary description of the parasites which we have found in American muskrats and later the more detailed descriptions.

The forms recorded by others are the following:

Leidy[2] mentions finding a number of trematodes in the small intestine of the muskrat which he placed in *Echinostomum echinatum* Zeder. He also found in the muskrat two specimens of a trematode which he says "appear to belong to *Amphistomum subtriquetrum* Rud." We question the correctness of the diagnosis of this trematode and suspect that they were specimens belonging to the new genus and species *Wardius zibethicus*.

Dr. B. H. Ransom reports an unidentified species of Filaria from the muskrat in the collection of the Bureau of Animal Industry, Washington, D. C.

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* Contributions from the Zoological Laboratory of the University of Nebraska, No. 113.

1. Barker, F. D., and Laughlin, J. W.: A new species of trematode from the muskrat, Tr. Am. Micr. Soc., 1911, 30, 261-274. Barker, F. D.: The Parasites of the Muskrat, Science, 1913, n. s., 37, 1268.

2. Leidy, Joseph: On the Trematodes of the Muskrat, Proc. Acad. Nat. Sci., Phila., 1888, 40, 126-127.

The forms which we have discovered are as follows:

TREMATODES

Echinostomum coalitum Barker and Beaver, *sp. nov.*[3] (Plate 1, Fig. 1).

Twenty-two specimens of an unusually large trematode were found among several hundred specimens of different species of trematodes in the intestines of forty-six muskrats. The condensed description of this species based on the specimens obtained is as follows:

Body much elongated, flattened dorso-ventrally, tapering posteriorly, slightly tapering anteriorly. When alive, color reddish or creamy, body very flabby. Length 22 to 30 mm., width at level of ovary 1.5 to 2.3 mm., at level of acetabulum 1 to 1.4 mm. Anterior part of body covered with minute spines. Well-defined reniform collar surrounds oral sucker. Collar has wide shallow or deep narrow indentation in posterior edge of ventral surface and bears 35 spines arranged in single or slightly alternate rows, 25 large spines on rim and 5 smaller spines on each lappet. Oral sucker circular, terminal, 0.37 to 0.46 mm. in diameter. Acetabulum at level of second anterior sixth of body, pouch like, strongly muscular, 1.37 to 1.60 mm. long by 1.12 to 1.32 mm. wide. Opening of sucker circular, very large, 0.72 mm. in diameter. Mouth and pharynx separated by tubular non-muscular prepharynx, 0.2 to 0.3 mm. long. Esophagus 1.03 to 3.2 mm. long. Intestinal ceca tubular, slightly undulating, increasing in caliber toward posterior end of body where they end blindly. Testes close together in median plane, at third fourth of body, one testis directly behind other; elliptical; anterior testis entire to four-lobed, posterior with smooth or undulating margin. Cirrus pouch large, gourd-shaped, with base to right or left at level of anterior third of acetabulum. Cirrus pouch encloses tubular, U-shaped seminal vesicle; voluminous granular prostate gland and large muscular-walled cirrus. Genital pore a little anterior to anterior margin of acetabulum.

Ovary ovoid, margin smooth or undulating, transverse, median, in anterior part of posterior half of body. Shell gland well defined, posterior to ovary and slightly larger than it. Seminal receptacle and Laurer's canal not evident. Yolk glands voluminous, of small spherical follicles, masses continuous, in lateral areas, extending from slightly caudad to acetabulum to extreme posterior end of body where they coalesce in the median plane, completely filling body posterior to testes. Transverse vitelline ducts and reservoir present at level

3. Abstract of unpublished research by Franklin D. Barker and Chester A. Beaver.

EXPLANATION OF PLATES

All drawings were made with a camera lucida from original specimens. The degree of magnification is indicated by a vertical line 1 mm. in length at the side of each figure.

Abbreviations

A D, Adhesive disc
Ac, Acetabulum
B C, Bursa copulatrix
C P, Cirrus pouch
Cr, Cirrus
Es, Esophagus
Ex, Excretory reservoir
G P, Genital pore
G Pa, Genital papilla
L C, Laurer's Canal
Ov, Ovary
P S, Posterior sucker
S, Sucker
S G, Shell gland
S R, Seminal receptacle
S V, Seminal vesicle
T, Testis
Ut, Uterus
Va, Vagina
V D, Vas deferens
V G, Vitelline glands
V R, Vitelline reservoir

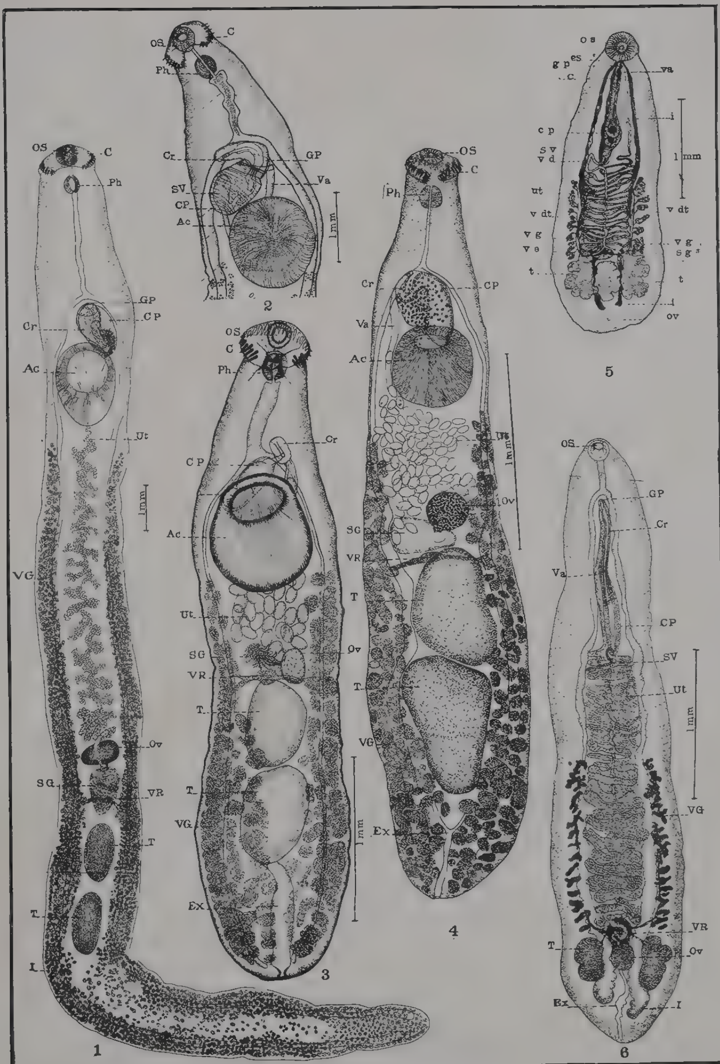

Fig. 1.—*Echinostomum coalitum* Barker and Beaver, ventral view, specimen slightly compressed.

Fig. 2.—*Echinostomum coalitum,* anterior end enlarged to show cirrus pouch and contents.

Fig. 3.—*Echinoparyphium contiguum* Barker and Bastron, ventral view, specimen compressed.

Fig. 4.—*Echinostomum callawayensis* Barker and Noll, ventral view, specimen compressed.

Fig. 5.—*Notocotyle quinqueseriale* Barker and Laughlin, ventral view.

Fig. 6.—*Catatropis filamentis* Barker, ventral view.

PLATE 2

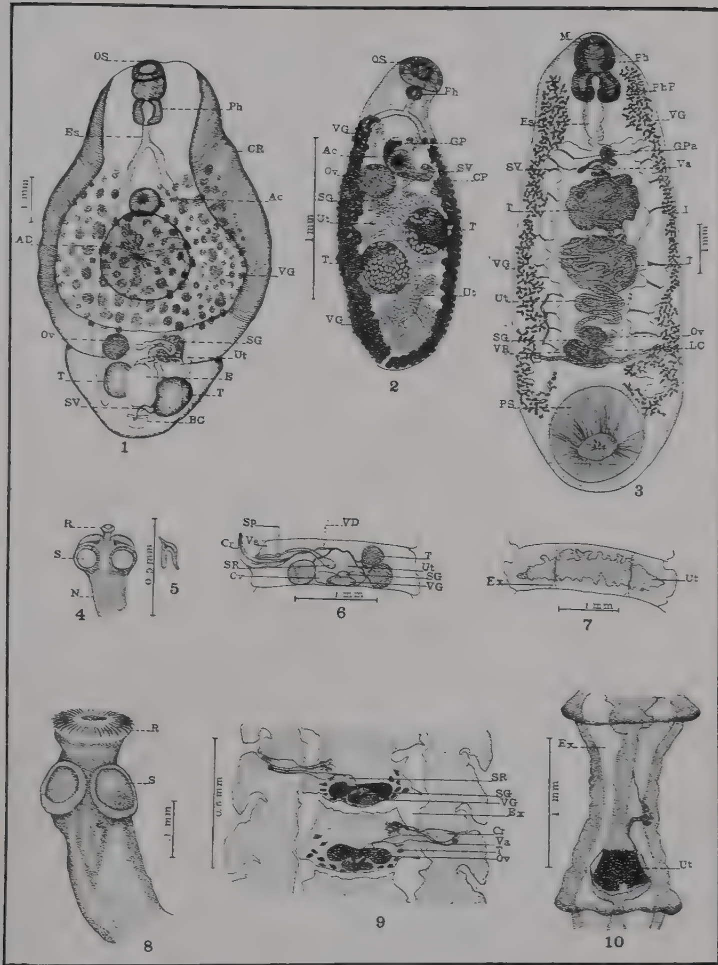

Fig. 1.—*Hemistomum craterum* Barker and Noll, ventral view.

Fig. 2.—*Plagiorchis proximus* Barker, ventral view.

Fig. 3.—*Wardius zibethicus* Barker and East, ventral view, specimen compressed.

Fig. 4.—Scolex of *Hymenolepis evaginata* Barker and Andrews.

Fig. 5.—Hook of *Hymenolepis evaginata.*

Fig. 6.—Mature proglottid of *Hymenolepis evaginata.*

Fig. 7.—Gravid proglottid of *Hymenolepis evaginata.*

Fig. 8.—Scolex of *Anomotaenia telescopica* Barker and Andrews.

Fig. 9.—Mature proglottid of *Anomotaenia telescopica,* reconstruction from frontal sections.

Fig. 10.—Gravid proglottid of *Anomotaenia telescopica.*

of shell gland. Uterus median with densely coiled transverse tubes extending from anterior testis to genital pore.

Eggs numerous, oval, light brownish color, 0.104 to 0.108 mm. by 0.067 to 0.070 mm. Lids small, opercular rim absent. Excretory reservoir tubular, in median plane of posterior part of body, forming a large bulb-like reservoir at extremity of body; excretory pore terminal, median.

Found in duodenum of host.

Echinoparyphium contiguum Barker and Bastron, *sp. nov.*[4] (Plate 1, Fig. 3).

Body spindle- or boat-shaped, flattened dorso-ventrally, anterior end tapering, posterior end bluntly rounded. Length 3.3 to 4.3 mm.; width 0.57 to 0.70 mm. at level of acetabulum. Oral sucker almost surrounded by well-defined collar with ventral median incision. Collar has 37 spines arranged in alternate rows of 14 oral and 15 aboral spines on rim and one set of 4 on each ventral flap or lappet. Cuticula smooth, without spines. Oral sucker subterminal, 0.12 to 0.16 mm. by 0.09 to 0.14 mm.

Large circular muscular acetabulum, 0.45 to 0.57 mm. in diameter at middle of anterior half of body. Oval muscular pharynx separated from mouth by short prepharyngeal tube. Wide, thin-walled esophagus extending from pharynx to level of acetabulum where it bifurcates; intestinal ceca extend straight to posterior end of body and end blindly.

Ovary small, ovoid, 0.16 to 0.19 mm. by 0.14 to 0.15 mm. in middle of body, slightly to left of median line. Shell gland diffuse, without definite outline, at level of ovary and to right of median line. Laurer's canal present. Seminal receptacle not evident. Testes very large, in anterior part of posterior half of body, median, one directly behind the other. Uterine coils loose, occupying intercecal zone between shell gland and acetabulum. Vagina opens with cirrus at genital pore just posterior to bifurcation of esophagus. Cirrus pouch club-shaped, extending from genital pore obliquely caudad, dextral and dorsal to acetabulum. Its base at level of middle of acetabulum. Large tubular seminal vesicle, granular prostate gland, and muscular cirrus lie within cirrus pouch.

Vitelline glands coarsely acinous, extending in continuous lateral masses from acetabulum to extreme posterior end of body. Masses more voluminous caudad to posterior testis. Transverse vitelline ducts and median vitelline reservoir at level of anterior margin of anterior testis. Eggs limited in number, from 30 to 100; oval, 0.096 to 0.109 mm. in length by 0.068 to 0.070 mm. in width. Lid present.

4. Extract of unpublished research by Franklin D. Barker and Carl Bastron.

Excretory system Y-shaped, lateral arms unite just caudad to posterior testis, forming large tubular median reservoir; excretory pore median and slightly ventral, at posterior end of body.

Found in duodenum of host.

Echinostomum callawayensis Barker and Noll, *sp. nov.*[5] (Plate 1, Fig. 1).

Body spatulate; anterior end tapering, posterior end bluntly rounded. Length 4.28 to 6.91 mm.; width 1.04 to 1.49 mm. Anterior end almost entirely surrounded by oval collar-like expansion, 0.34 to 0.51 mm. wide, having a definite ventral incision. Collar armed with double row of alternately arranged spines varying in number from 37 to 41, 31 to 33 on rim and 2 to 5 on each flap. Length of collar spines 0.0385 to 0.056 mm., mid-dorsal spine being smallest. Cuticula smooth, without spines. Acetabulum circular, cavity sac-like, musculature well developed, lying between first and second anterior fourths of body.

Oral sucker 0.08 to 0.16 mm. long by 0.12 to 0.17 mm. wide, separated from pharynx by short narrow prepharyngeal tube. Weakly developed but wide esophagus bifurcates into narrow ceca which broaden posterior to acetabulum and end blindly between posterior testis and posterior end of worm. Testes more or less elliptical, lying tandem in anterior three-fourths of posterior half of body. Cirrus pouch, pear-shaped, containing thick, muscular-walled cirrus, tubular somewhat coiled seminal vesicle, and granular prostate gland; pouch right or left and anterior to middle of acetabulum. Genital pore right or left of median line and anterior to acetabulum.

Ovary nearly globular, in middle of body right or left of median line; large, compact, well-defined, pear-shaped shell gland between ovary and anterior testis. Uterine coils compact, almost entirely anterior to ovary, filling region between intestinal ceca. Laurer's canal present; seminal receptacle not found. Eggs numerous, straw colored, oval, lid small, without opercular rim; length 0.0805 to 0.1015 mm., width 0.042 to 0.063 mm. Vitelline glands coarsely acinous, extending from posterior border of acetabulum in continuous lateral masses to posterior end of worm; posterior to testis vitelline glands extend toward median line but do not coalesce. Transverse vitelline duct and reservoir at level of anterior margin of anterior testis.

Excretory system Y-shaped, with slender median reservoir; excretory pore in median line at posterior end of worm.

Found in duodenum of host.

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5. Extract of unpublished research by Franklin D. Barker and William C. Noll.

Echinostomum armigerum Barker and Irvine, *sp. nov.*[6] (Text Fig. *A*).

Body elliptical, somewhat flattened dorsoventrally, anterior end slightly tapering, posterior end wider and more rounding. Length 9.4 to 12.4 mm.; width 1.2 to 1.8 mm. When alive pinkish gray color. Oral sucker almost completely surrounded by well-developed collar bearing 37 chitinous spines arranged in three sets, 27 around rim and 5 on each ventral point of collar. Collar spines vary in length from 0.061 to 0.094 mm., those on points of collar being smallest. Well marked median ventral break in collar. Anterior third of body covered by small spines 0.030 mm. long. Acetabulum prominent, pouch-like at juncture of anterior and middle thirds of body.

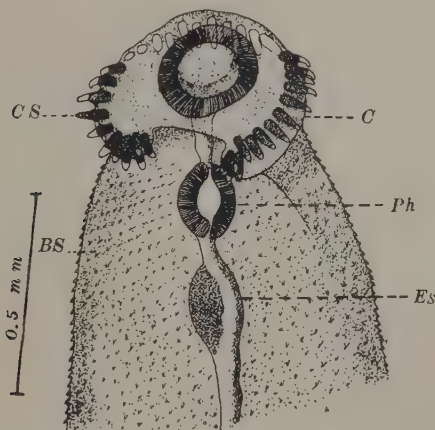

Fig. A.—Anterior end of *Echinostomum armigerum: Bs,* body spinelets; *C,* collar; *Cs,* collar spines; *Es,* esophagus; *Ph,* pharynx.

Digestive tract well developed; intestinal ceca somewhat undulating and rather narrow, ending blindly in extreme posterior end of worm. Testes quadrate to triangular, irregularly lobed, lying tandem and close together between middle and posterior thirds of body. Cirrus pouch pear shaped, surrounding large thick walled cirrus, and tubular somewhat coiled seminal vesicle, at level of anterior margin of acetabulum. Genital pore median between anterior margin of acetabulum and transverse arms of ceca.

Ovary pear-shaped, anterior to testes, median, transverse. Well-defined shell gland, slightly larger than the ovary, between anterior

6. Extract of unpublished research by Franklin D. Barker and Robert S. Irvine.

testis and ovary, slightly to one side. Laurer's canal and seminal receptacle not found. Uterine coils fairly compact, in transverse coils for most part anterior to ovary in median field. Eggs numerous, straw-colored, ovoid, operculum small and without opercular rim; size 0.084 to 0.105 mm. by 0.057 to 0.066 mm.

Vitelline glands coarsely acinous, extending in continuous masses, from acetabulum, in lateral fields, to posterior end of worm. Transverse vitelline ducts and reservoir at level of shell gland. Excretory system two lateral vessels which unite in region of posterior third of body and form slender median excretory reservoir; excretory pore in median line at posterior end of worm.

Found in duodenum of host.

Notocotyle quinqueseriale Barker and Laughlin, (Plate 1, Fig. 5).

Characters in general like those of genus. Ventral surface provided with five distinct longitudinal rows of wart-like papillae extending from anterior to posterior end, with 16 to 18 papillae in each row. Cuticula without spines. Length of body, 2.5 to 4.0 mm.; width 0.66 to 1.33 mm. Cirrus pouch elongated, extending from posterior margin of oral sucker to middle third of body. Vagina as long as cirrus pouch. Eggs light straw color, oval, with long polar filament at each end; 0.019 to 0.021 mm. long, 0.01 to 0.013 mm wide. Polar lid present. Most abundant parasite found; generally occurs in cecum.

Catatropis fimbriata Barker, *sp. nov.*[7] (Plate 1, Fig. 6).

Body thin, flat, gradually tapering anteriorly. Length 2.2 to 3.3 mm., width at level of testes 0.56 to 0.70 mm. Anterior half of body covered with minute needle-like spines in definite oblique rows. Three longitudinal rows of flattened circular papillae on ventral surface; 12 to 13 papillae in each row. Oral sucker, sub-terminal, oval 0.079 to 0.099 mm. wide, 0.066 to 0.092 mm. long. Pharynx absent; esophagus 0.105 to 0.132 mm. long; intestinal ceca undulating, external to uterine coils, internal to testes, end blindly in posterior end of worm. Testes opposite, at same level in posterior fifth or sixth of body, weakly two- to four-lobed; 0.198 to 0.257 mm. long, 0.132 to 0.151 mm. wide; vas deferens prominent, median, extends from shell gland to base of cirrus pouch; cirrus pouch tubular, greatly elongated, extends from level of intestinal bifurcation caudad to level of middle third of body. Seminal vesicle coiled at base of and almost entirely outside of cirrus pouch. Prostate gland and muscular cirrus covered with papillae within pouch. Ovary between testes, globular or oval, margin undulating 0.132 mm. long by 0.105 to 0.112 mm. wide. Uterine coils transverse, numerous compact, in intercecal zone. Vagina straight, walls

7. Abstract of unpublished research by Franklin D. Barker.

quite muscular, as long as cirrus pouch. Genital pore ventral, median, just caudad to intestinal bifurcation. Shell gland, compact, definite, ovoid, immediately anterior to and a little larger than ovary.

Vitelline glands, lateral in extracecal zone in posterior half of body, extending from middle of body caudad to level of testes, 12 to 15 rather definite, irregular acini on each side. Excretory canal tubular, undulating, extends in median line from ovary to posterior end of body. Eggs elongated, oval, 0.020 to 0.022 mm. long, 0.011 mm. wide; shell thick, with lid and long polar filament at each end, 0.084 to 0.098 mm. long.

Found in duodenum of host.

Hemistomum craterum Barker and Noll, *sp. nov.*[8] (Plate II, Fig. 1).

Body divided into cephalic and caudal regions; cephalic region thin, flat, wide, anterior portion tapering, lateral margins turn ventrad and mesad one fifth width of region; caudal region thick, rounding, conical. Length of entire worm 0.75 to 1.89 mm. Length of cephalic region 0.62 to 0.79 mm., width 0.41 to 0.49 mm.; length of caudal region 0.28 to 0.47 mm., width 0.20 to 0.36 mm.

Body spines not evident. Oral sucker muscular subterminal, nearly circular, 0.075 to 0.094 mm. in diameter. Acetabulum at posterior margin of anterior half of cephalic region, circular, 0.075 mm. in diameter. Adhesive disk large, flattened cone with crater-like top, muscular without papillae; median in anterior portion of posterior half of cephalic region. Frequently overlaps acetabulum. Size 0.19 to 0.22 mm. in diameter.

Pharynx oval, 0.07 mm. long by 0.073 mm. wide. Esophagus narrow, straight, 0.06 mm. long. Intestinal ceca narrow, tubular, undulating, terminating blindly in posterior end of caudal region. Ovary at junction of body regions to right of median line. Globular, margins smooth 0.07 mm. in diameter. Shell gland diffuse, in same plane but on opposite side from ovary.

Uterus, winding turns to left then caudad to bursa copulatrix, which is dorsal and subterminal in posterior end of worm. Vitelline glands voluminous globular acini, filling posterior two thirds of cephalic region. Testes two, globular or oval, entire or slightly lobed at about middle level of caudal region on either side of median line, slightly oblique. Twice as large as ovary. Seminal vesicle, large, winding tube slightly to left of median line between testes; opens into bursa. Genital pore slit-like, dorsal, median, subterminal, at posterior end of worm. Eggs, large, oval, few, one to three; thin shell, small operculum, size 0.11 by 0.07 mm.

8. Abstract of unpublished research by Franklin D. Barker and William C. Noll.

Found in duodenum and cecum of host; only in one out of forty-six muskrats examined.

Plagiorchis proximus Barker, *sp. nov.*[9] (Plate II, Fig. 2).

Body plump, oval, tapering anteriorly, bluntly rounding posteriorly. Color creamy, opaque. Minute spinelets cover anterior two thirds of body. Length 1.32 to 1.98 mm., width at level of anterior testis 0.49 to 0.66 mm. Oral sucker muscular, terminal, 0.085 to 0.125 mm. long by 0.105 to 0.115 mm. wide. Pharynx immediately posterior to oral sucker, 0.035 to 0.05 mm. long by 0.045 to 0.055 mm. wide. Esophagus as long as pharynx. Intestinal ceca, simple, straight, extend almost to posterior end of body. Acetabulum, between first and second fourths of body; muscular, circular, 0.065 to 0.11 mm. long by 0.075 to 0.105 mm. wide. Ovary, globular to oval, margins smooth, immediately posterior to acetabulum and to right of median line. Margin separated by width of cirrus pouch, or touches posterior margin of acetabulum. Size 0.095 to 0.145 mm. long by 0.10 to 0.11 mm. wide. Uterine coils winding, descending limb passes caudad from ovary between testes filling posterior end of body, ascending limb passes between testes cephalad to genital pore; coils overlap testes but do not overlap intestinal ceca. Eggs very numerous. Vitelline glands voluminous, coarse globular acini lateral and partly dorsal and ventral, extend uninterrupted from slightly anterior to acetabulum to extreme posterior end where they tend to fuse; glands overlap and obscure intestinal ceca; shell gland, diffuse, posterior and to left of ovary. Seminal receptacle and Laurer's canal not evident. Testes, globular, margins smooth, in anterior portion of posterior half of body, one obliquely behind the other, slightly separated. Testes measure 0.125 to 0.160 mm. long by 0.120 to 0.150 mm. wide. Cirrus pouch, narrow, elongated, tubular; base just posterior to acetabulum and to left of median line; pouch turns transversely to right then cephalad dorsal and to right of acetabulum to the genital pore. Genital pore in median plane just anterior to acetabulum. Eggs numerous, straw color, operculum, with rim present, opercular end broad, opposite end tapering. Size 0.032 to 0.0378 mm. long by 0.020 to 0.024 mm. wide.

Found in duodenum of host.

Wardius zibethicus Barker and East, *Gen. et sp. nov.*[10] (Plate II, Fig. 3).

Large thick worms, 4 to 13 mm. long by 1 to 4.5 mm. wide; body broadly oblanceolate; anterior end tapering and bluntly conical, posterior end broader and rounded. Cuticula smooth without spines or

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9. Abstract of unpublished research by Franklin D. Barker.

10. Abstract from unpublished research by Franklin D. Barker and Anna M. East.

wart-like projections. Oral sucker absent; large muscular, cup-shaped sucker, posterior, ventral and subterminal; antero-posterior diameter 1.116 to 2.79 mm., transverse diameter 1.116 to 2.294 mm.; opening of sucker 0.3 to 1.55 mm. in diameter. Small, terminal mouth leads directly into muscular, elongated, cup-shaped pharynx (or oral sucker), size 0.434 to 0.992 mm. by 0.434 to 0.992 mm. pharynx with two dorsal, postero-lateral pockets often as large as pharynx; 0.45 to 1.08 mm. in length by 0.45 to 0.99 mm. in breadth. Pharynx leads into well-developed simple esophagus, without muscular thickenings; 0.62 to 2.17 mm. long and 0.186 to 0.30 mm. wide, bifurcating at level of first and second fourths of body; intestinal ceca sinuous, with numerous short lateral pockets, terminating blindly at level of anterior margin of posterior sucker.

Two testes weakly, but not regularly lobed, close together in tandem position in middle third of body. Testes vary from orbicular to transversely elliptical, 0.496 to 1.736 mm. in length by 0.496 to 2.294 mm. in width.

Male genital tract terminates in much convoluted and distended vesicula seminalis followed by slightly convoluted pars musculosa and pars prostatica surrounded by prostate gland. Short ductus ejaculatorius opens at base of genital papilla, ventral, right or left of median plane just posterior to intestinal bifurcation and slightly anterior to anterior margin of anterior testis; hermaphroditic duct and genital sucker absent. Ovary median, at level of posterior third of body, orbicular or transversely oval with smooth or undulating margin. Shell gland somewhat diffuse, right or left of, and posterior to ovary. Laurer's canal right or left and posterior to ovary; opening dorsal, median, slightly anterior to posterior sucker. Vitelline glands small globular acini, continuous, extending from level of pharynx to middle of posterior sucker, almost entirely outside of intestinal ceca. Two transverse vitelline ducts and prominent yolk reservoir at level of shell gland. Uterus in median plane, anterior to the ovary. Coils transverse, loose to compact. Metraterm opens at base of genital papilla through common genital pore.

Eggs, elongated, oval, numerous; opercular end tapering, 0.016 to 0.019 mm. by 0.009 to 0.014 mm. Operculum small, opercular rim absent. Excretory system complex consisting of two longitudinal canals, mesal of intestinal ceca, with numerous anastomizing laterals, extending from anterior end to posterior sucker where they empty into large vesicular reservoir dorsal and in part posterior to anterior margin of posterior sucker. Excretory pore dorsal, median at level of anterior margin of posterior sucker.

Generally found in cecum of host.

CESTODES

Hymenolepis evaginata Barker and Andrews, *sp. nov.*[11] (Plate II, Figs. 4, 5, 6, 7).

Worms 20 to 40 cm. long, 300 to 900 proglottids. In living worm posterior three centimeters greatly contracted, thick, rigid, opaque, anterior portion of body abruptly becomes thin, flabby, transparent. Proglottids four to eight times wider than long. Gravid posterior proglottids 2 to 3 mm. by 0.36 mm., anterior proglottids 0.15 to 0.30 mm. by 0.045 mm. Lateral edges project slightly. Genital pores unilateral in middle of proglottid. Scolex well developed, inverted pear-shaped, 0.33 mm. wide; four muscular circular suckers present, 0.09 to 0.11 mm. in diameter. Rostellum elongated, retractile, pestle-shaped, armed with single row of ten comparatively large hammer-shaped hooks, 0.007 mm. long by 0.004 mm. wide. Three testes, large, globular; one on one side and two, one obliquely anterior to other, on opposite side. Cirrus elongated, muscular, posterior to vagina. Ovary transversely elongated, bilobed, median, posterior; vitelline gland, transversely elongated, median, behind ovary. Shell gland oval, median, anterior to vitelline gland. Mesal end of vagina swollen to form seminal receptacle anterior to ovary. Vagina opens anterior to cirrus. Gravid uterus transversely elongated, sac-like, anterior and posterior margins lobulated, partitions absent. Eggs oval, thin shell, 0.0206 by 0.0162 mm.

Found in duodenum of host.

Anomotaenia telescopica Barker and Andrews, *sp. nov.*[12] (Plate II, Figs. 8, 9, 10).

Preserved specimens 115 to 130 mm. long, with 600 to 700 proglottids. Body heavy, rugged, opaque, proglottids markedly telescoped, edges serrated, mature proglottids four to five times wider than long, gravid proglottids three to four times longer than wide. Mature proglottids 1.1 mm. wide; 0.5 mm. long, 0.17 mm. thick. Gravid proglottids 1.5 mm. long by 0.5 mm. wide. Genital pores irregularly alternate. Scolex well developed 0.17 mm. wide with four muscular, circular, cup-shaped suckers. Rostellum strongly developed, wide, armed with double row of forty-eight alternately arranged, elongated hooks. Inner row of twenty-four hooks, 0.057 mm. long; outer row of twenty-four hooks 0.047 mm. long.

Testes limited in number, in lateral and posterior regions of mature proglottids. Cirrus pouch short, muscular, anterior to vagina. Ovary transversely elongated, weakly bilobed, median, posterior. Vitelline gland compact elongated, median, posterior to ovary. Shell gland

11. Abstract of unpublished research by Franklin D. Barker and Mitchell Andrews.

12. Abstract of unpublished research by Franklin D. Barker and Mitchell Andrews.

oval, median, anterior to vitelline gland. Seminal receptacle prominent, sac-like, anterior to ovary. Vagina elongated, muscular. Uterus, sac- or pouch-like in posterior portion of gravid proglottids, without median stem or lateral branches. Eggs spherical, 0.013 mm. in diameter, shell thick.

Found in duodenum of host.

NEMATODA

Trichuris opaca Barker and Noyes, *sp. nov.*[13] (Text Fig. *B*).

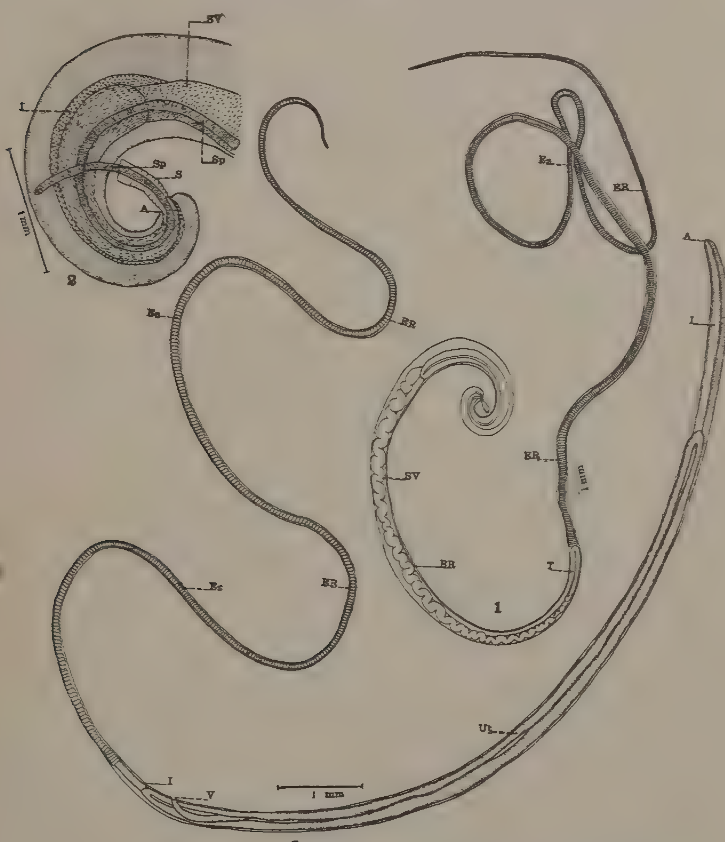

Fig. B, 1.—*Trichuris opaca,* male. Fig. 2.—*Trichuris opaca,* posterior end of male. Fig. 3.—*Trichuris opaca,* female. *A,* anus; *B R,* body region; *E R,* esophageal region; *Es,* esophagus; *I,* intestine; *S,* Spicule sheath; *Sp,* spicule; *S V,* seminal vesicle; *T,* testis; *Ut,* uterus; *V,* vulva.

13. Abstract from unpublished research by Franklin D. Barker and Bessie Noyes.

Body cylindrical, stiff, opaque, divided into long slender esophageal region and shorter, thicker body region. Anterior portion attenuated, tapering, rounded; posterior blunt, rounded; anus a little subterminal.

Male: 22 to 28 mm. long; esophageal region 13 to 19 mm. long, 0.06 to 0.08 mm. wide; body region 7 to 9 mm. long, 0.14 to 0.16 mm. wide. Posterior end rolled into spiral. Spicule 2 mm. long by 0.017 mm. broad surrounded by sheath covered by minute blunt spinelets; sheath when evaginated 0.18 mm. long by 0.07 mm. broad.

Female: 28 to 30 mm. long; esophageal region 18 to 19 mm. long, 0.06 to 0.07 mm. wide; body region 10 to 11.1 mm. long, 0.23 to 0.25 mm. wide. Posterior portion slightly curved. Vulva between first and second anterior elevenths of body region. Anus nearly terminal.

Found in duodenum of host.

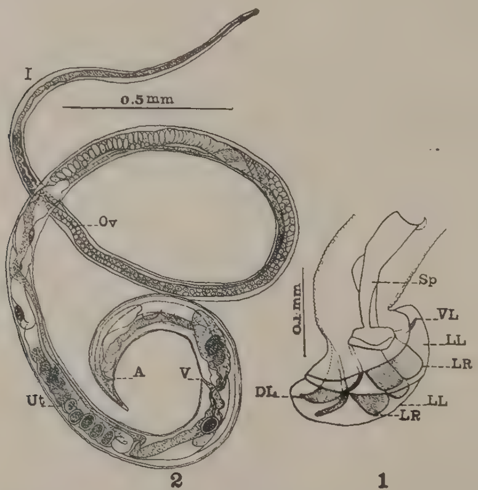

Fig. C, 1.—*Trichostrongulus fiberius*, posterior end of male. Fig. 2.—*Trichostrongylus fiberius*, female. *A*, anus; *D L*, dorsal lobe; *D L R*, dorso-lateral lobe; *I*, intestine; *L L*, lateral lobe; *L R*, lateral ray; *Ov*, ovary; *Sp*, spicule; *Ut*, uterus; *V*, vulva; *V L*, ventro-lateral ray.

Trichostrongylus fiberius Barker and Noyes, *sp. nov.*[14] (Text Fig. *C*).

Body thread-like, anterior region greatly attenuated, body gradually widens toward posterior end. Buccal cavity and teeth absent.

Male: 2.8 mm. long; width just posterior to mouth 0.013 mm., anterior to bursa 0.09 mm. Bursa with two wide lateral lobes and

14. Abstract from unpublished research by Franklin D. Barker and Bessie Noyes.

narrow dorsal median lobe. Lateral lobes with two wide, blunt, lateral rays and one narrow, pointed dorso-lateral and one ventro-lateral ray. Spicules short and heavy.

Female: 4.7 mm. long; width posterior to mouth 0.03 mm., at level of vulva, 0.135 mm. Vulva in posterior ninth of body 0.52 mm. from end. Anus 0.08 mm. from posterior end. Posterior end slightly curved and pointed. Eggs oval, segmented, 0.059 by 0.036 mm., shell, thick.

Found in duodenum and cecum of host.

Capillaria ransomia Barker and Noyes, *sp. nov.*[15] (Text Fig. *D*).

Body capillary, not divided externally into two regions, gradually increasing in width in body region. Anal opening subterminal.

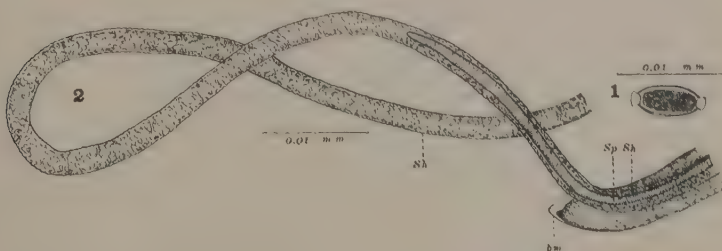

Fig. D, 1.—Egg of *Capillaria ransomia.* Fig. 2.—Caudal region of male, *Capillaria ransomia,* lateral view; *bm,* bursal membrane; *sh,* spicule sheath; *sp,* spicule.

Male: 19.6 mm. long, width posterior to mouth 0.01 mm., in posterior region 0.032 mm. Posterior end slightly curved; small bursa present with two lateral lobes; one spicule, 1.36 mm. long by 0.007 mm. wide; spicule sheath 0.01 mm. wide.

Female: 19 mm. long; width posterior to mouth 0.022 mm., posterior region 0.065 mm. Vulva in anterior fourth of body, 5 mm. from anterior end. Eggs with prominent plugs, 0.05 mm. by 0.02 mm.

Found in duodenum of host.

It is hoped that these preliminary descriptions will stimulate and facilitate further investigations of the parasites of the muskrat in other localities.

15. Abstract from unpublished research by Franklin D. Barker and Bessie Noyes.

GORDIUS LARVAE PARASITIC IN A TREMATODE *

William Walter Cort
Macalester College, Saint Paul, Minn.

During the summer of 1914 while carrying on investigations at the University of Michigan Biological Station, Douglas Lake, Michigan, I collected some trematodes which contained in their parenchyma early developmental stages of Gordius larvae. This observation seems worth reporting, especially since no record has been found of a trematode parasitized by another animal.

These trematodes, which belong to the species *Brachycoelium hospitale* Stafford, were found in the intestines of specimens of the green newt (*Diemictylus viridescens*) from a small beach pool on the north side of Douglas Lake. The anatomy of this fluke has been described by Stafford (1903 : 824). The infection of the Douglas Lake newts while not particularly heavy is considerably greater than that reported by him. Of nineteen individuals of *Diemictylus viridescens* examined, thirteen were infected with a total of thirty-seven specimens of *Brachycoelium hospitale*, the greatest number in one host being eight.

The accidental finding of a Gordius larva coiled up in the parenchymatous tissue of one of the trematodes led to further examination. In all, sixteen of the trematodes were examined carefully for the presence of these larvae. Eight of them from several different hosts were infected, two containing two larvae and the others one each. The Gordius larvae were found in various positions: one was next to the oral sucker, another just anterior to the ovary, and others near the testes or further posteriad among the uterine coils (Fig. 1).

The Gordius larvae in the trematodes were in a very early stage of development, being but little beyond the condition found in fully developed eggs. They floated freely in spaces in the parenchymatous tissue. No spontaneous movement was noted and there was no indication of a cyst. The larvae were coiled very tightly; the anterior end appeared truncated, and the proboscis entirely retracted. The posterior extremity was terminated by a short spine (Fig. 2). There was no indication that the larvae were continuing their development in the tissues of the trematode.

Early larval stages of the Gordiacea have been found in a large variety of aquatic animals. Villot (1891 : 338) states that the "embryo" of *Gordius aquaticus* has been found in the mesenteries of *Rana tem-*

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* Publication No. 31 from the University of Michigan Biological Station.

poraria, in aquatic insect larvae (*Tanypus, Corethra, Chironomus*), in the parenchyma of leeches, in the mucous membrane of the intestine of fishes, and even in the foot of snails. Which of these are normal hosts is a matter of dispute, some authorities favoring the insect larvae and some the fishes. The presence of Gordius larvae in trematodes from the intestine of the newt is without doubt a case of accidental parasitism, the larvae ingested by the newt having sought to escape the

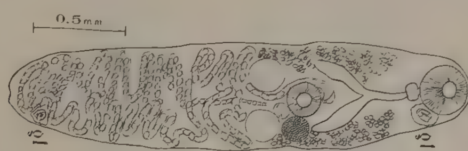

Fig. 1.—A specimen of *Brachycoelium hospitale* containing two Gordius larvae (*gl*). X 28.

intestinal juices by boring into the trematodes. That the trematode can have any normal place in the life-history of Gordius is evidently unlikely since the adult trematode finishes its life in the intestine of its host and under these conditions the encysted larvae can hardly reach a place suited for further development. Probably after hatching from the egg Gordius larvae by the use of their extraordinary boring apparatus are able to make their way into almost any aquatic animal.

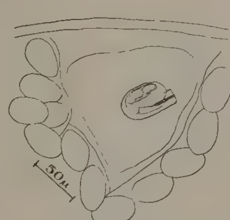

Fig. 2.—Gordius larva in parenchyma of posterior end of fluke shown in Figure 1. X 160.

Many of them wander into places where development stops; but the continuation of the species depends on a few of the myriads hatched finding some normal host, i. e., one in which complete development is possible. The life history thus appears to be only roughly adjusted and to lack the precise relations shown by many other parasitic species.

LITERATURE CITED

Stafford, J. 1903. Two Distomes from Canadian Urodela. Centralbl. Bakteriol. u. Parasit., (1) Orig., 34: 822-830.

Villot, A. 1891. L'Evolution des Gordiens. Ann. sci. nat., Zool., 11: 329-401.

SOCIETY PROCEEDINGS

THE HELMINTHOLOGICAL SOCIETY OF WASHINGTON

The twenty-fifth regular meeting of the Society was held at the residence of Dr. Stiles on March 26, 1915, Dr. Stiles acting as host and Dr. Ransom as chairman.

Dr. Cobb presented some figures of a species of *Bunonema,* pointing out the fact that the large cuticular bosses, which had been described by other workers as dorsal or ventral, were really located on the right side of the worm in this genus, the animal in consequence being notably asymmetrical.

Dr. Cobb also gave a demonstration of the workings of the new Bausch & Lomb projection apparatus, using the nitrogen-filled, tungsten-filament bulb.

Dr. Stiles gave a résumé of the sanitary campaign in some parts of the southern United States, and pointed out the considerable advantage to be gained by methods of civic education as opposed to the use of military and police methods. Educational methods work from the inside, and secure cooperation without arousing hostility. In actual practice, the greatest reforms accomplished anywhere in the South were accomplished without the arrest of a single individual or the imposition of one fine. A striking economic feature of the work in Wilmington, North Carolina, was the appropriation of $50,000 by the city to be used as a loan fund for the installation of sewer service. Any person financially unable to install sewer service could borrow the necessary money from the city, the city taking a lien on the property for the loan, and could pay the money back in easy instalments, the city charging 6 per cent. interest on the loan.

Dr. Hall presented a paper entitled "A Case of *Taenia saginata* Presenting Structural Abnormalities and Associated with Spurious Parasitism in an Infant."

Dr. Ransom exhibited some specimens of trichinae digested out of meat exposed three weeks to temperatures of 15, 10 and 5 F., respectively, and for comparison some specimens digested out of unfrozen meat. The normal trichinae examined at room temperature were seen to be tightly coiled; the esophageal cell body was brown in color; its nuclei clear and vesicular, and the reproductive cells formed a continuous hyaline mass. Those from meat exposed to 15 F. were less tightly coiled; the color of the cell body was less pronounced; the granulation of the protoplasm of the esophageal cells differed somewhat from normal, and in some cases there was a tendency toward dissociation of the reproductive cells. Those from meat exposed to 10 F. were loosely coiled, and in many cases had assumed the form of a figure 6; the color of the cell body was much paler than normal; the nuclei of the esophageal cells were more or less solidified; the protoplasm of these cells was abnormally granular, and the reproductive cells were more or less dissociated, tending toward a spherical form. The larvae from meat exposed to 5 F. had assumed the form of a figure 6; the esophageal cell body had entirely lost its brown color; the nuclei were solidified or not apparent; the protoplasm showed a pronounced abnormal granulation, and the reproductive cells were either dissociated or broken down into a granular mass. The exact nature of the changes produced by low temperatures is not known, but it is evident that the changes become more marked as the temperature becomes lower. Possibly there is a separation of colloids which are unable after thawing to resume their former relations in the protoplasmic complex. The viability of the larvae is materially affected by exposure to low temperatures. Infections may result after exposure to temperatures of 10 F. and 15 F., but none has resulted in numerous trials from the feeding of meat exposed for

three weeks to temperatures of 5 F. and lower. Examined on a warm stage most of those exposed to 15 F. are active motile; a smaller proportion of those exposed to 10 F. are active, whereas none of those exposed to 5 F. or lower have exhibited other than very feeble movements, and only very rarely have they shown even the faintest signs of life.

MAURICE C. HALL, *Secretary.*

The twenty-sixth regular meeting of the Society was held at the residence of Dr. Ransom on April 22, 1915, Dr. Ransom acting as host and Mr. Crawley as chairman.

Dr. Stiles presented a paper on the parasites of schoolchilren in a Southern city. The data were tabulated with regard to race, sex and the presence of sewer connections or privy in the home of the pupil. Of 2,448 white children, fecal samples were obtained from 776; and of 1,346 negro children, fecal samples were obtained from 511. Of the total number of children, 2,448 white and 1,346 negro, 20 per cent. of the white children and 76 per cent. of the negro children were from homes with privies. A higher percentage of samples was obtained from negro children (38 per cent.) than from white children (32 per cent.), showing that it is possible to obtain the cooperation of the negroes to a notable extent, if the cooperation is sought in the right manner. The poorer showing of the white children is to be explained in part by the natural diffidence displayed by white girls, samples being obtained from only 26 per cent. of these.

Of 776 white pupils, 36.73 per cent. had intestinal parasites, and of 511 negroes, 49.12 per cent. had intestinal parasites. It is evident, then, that the negroes, coming from homes usually provided with privies (76 per cent.) and seldom with sewer connections, have a higher infestation than white children coming from homes usually provided with sewer connections and seldom provided with privies (20 per cent.). However, the percentage of infestation among negro boys and girls was practically identical, indicating a similar degree of cleanliness or lack of it for both sexes, whereas the percentage of infestation among white boys was higher than among white girls, indicating a greater degree of cleanliness among the white girls as compared with white boys. The white boys from homes provided with sewers showed a greater degree of infestation than white girls from homes having only privies. It may be surmised that this follows not only from the greater cleanliness of the white girls, but a more roving disposition on the part of the white boy. The white boys from home having privies showed a greater infestation than negro boys and girls from similar homes, but in connection with these figures it should be noted that the number of white boys in this category is very small and the resultant percentage less apt to be reliable or representative.

Parasites were considered in two groups: 1. Those that could only be acquired as the result of ingesting human feces in some way, and including Entameba, Lamblia, Trichomonas, Oxyuris, Ascaris and Trichuris. 2. Those that might be acquired in some other way, including Hymenolepis and Necator.

Of the 776 white children, 28 per cent., and of 511 negro children, 48 per cent., were infested with parasites of the first group, the infestation for each parasite being as follows: *Entameba coli,* 8.7 per cent. of whites and 11.9 per cent. of negroes; Lamblia, 12.7 per cent. of whites and 6.5 per cent. of negroes; Trichomonas, only 5 infestations, all in whites, 0.6 per cent.; *Ascaris lumbricoides,* 7.5 per cent. of whites and 27.9 per cent. of negroes; *Oxyurias vermicularis,* only 3 infestations, all in whites, 0.4 per cent.; *Trichuris trichiura,* 1.3 of whites and 11.5 per cent. of negroes.

Of the same children, 10.9 per cent. of the white children and 3.5 per cent. of the negroes were infested with parasites of the second group, the infestation for each parasite being as follows: *Hymenolepis nana,* only 3 cases, 0.3 per cent. of whites and 0.2 per cent. of negroes; *Necator americanus,* 10.7 per cent. of whites and 3.3 per cent. of negroes. The question may be raised as to whether the thicker skin and the odor of the feet may serve as a protection in the case

of the negro, or whether there is a partial resistance developed in the native home of the parasite and of the negro in Africa.

Dr. Ransom presented a note reporting a case of *Paragonimus westermanii* or *P. kellicotti* in a cat. The diagnosis is based upon eggs found in the bronchial mucus and muscles by Dr. W. H. Schultz of Morgantown, West Virginia, specimens of which were sent to the Bureau of Animal Industry for identification. Cases of *Paragonimus* are occasionally found in hogs killed at certain meat inspection stations, particularly at Cincinnati, Ohio, but none of these cases has been traced to the point of origin. Hence the present case is of special interest, as it indicates a probable center of infection, in the neighborhood of which other cases may be expected to occur.

Mr. Crawley presented a note on the geometrical ratio of multiplication in the increase of protozoa in infestation, with an apparent exception in the case of sarcosporidia.

The presence of *Sarcocystis muris* in a mouse from which the skin has been removed, is readily detected. The cysts, owing to the presence of refractive granules, look like white threads running lengthwise in the muscles. When scarce, however, they may be confused with the connective tissue fibers or even overlooked altogether, and such cases can only be positively diagnosed by the use of the microscope.

In the case of thirteen mice, which either died or were killed at known periods after inoculation, five were macroscopically negative, but the microscope showed them to be positive. The periods elapsing between inoculation and death were, respectively, 75, 75, 83, 211 and 273 days.

The remaining eight mice were all macroscopically positive, and the character of the infections was classified as slight, moderate and severe, the latter being those cases wherein the flesh of the mouse is so overloaded with cysts that, considered as a whole, it is white and not red. The slight infections numbered two, with periods of 100 and 205 days. The moderate infections numbered four, with periods of 158, 175, 225 and 233 days. The two severe infections had periods of 216 and 233 days.

The indications from these data are that the time during which the infection has lasted and the intensity it finally assumes bear no relation to each other. Thus, two of the cases which required the microscope for their demonstration had periods of 211 and 273 days, whereas the periods for the two severe cases were only 216 and 233 days.

Hence the inference is that the number of cysts which finally appear in the muscles is directly related to the number of spores originally ingested. If so, this would constitute a noteworthy exception to the general rule for infections of parasitic protozoa to the effect that the severity an infection ultimately attains bears no relation to the number of individuals originally inoculated. This, of course, is due to the fact that, in general, the parasites increase in geometrical ratio, and continue to do so until the host succumbs or establishes a successful resistance. This latter contingency cannot be invoked in the present case, since *Sarcocystis muris* is fatal to mice.

The data above given were obtained only incidentally in the course of a study of the life history of *S. muris*, and hence cannot be regarded as at all conclusive.

MAURICE C. HALL, *Secretary*.

APPENDIX

For the convenience or information of investigators, attention is called to the place of publication of the earlier proceedings of the Helminthological Society of Washington. Previous to publication in THE JOURNAL OF PARASITOLOGY, all the Proceedings were published in *Science*, as follows:

Vol. 33, new series, No. 840, pp. 197-198, Feb. 3, 1911 (first and second meetings).

Vol. 33, new series, No. 848, pp. 510-512, March 31, 1911 (third meeting).

Vol. 33, new series, No. 850, pp. 590-592, April 14, 1911 (fourth meeting).

Vol. 33, new series, No. 860, pp. 974-976, June 23, 1911 (fifth and sixth meetings).

Vol. 35, new series, No. 901, pp. 553-556, April 5, 1912 (seventh, eighth and ninth meetings).

Vol. 35, new series, No. 903, pp. 635-636, April 19, 1912 (tenth meeting).

Vol. 35, new series, No. 906, p. 756, May 10, 1912 (eleventh meeting).

Vol. 37, new series, No. 941, p. 78, Jan. 10, 1913 (twelfth meeting).

Vol. 37, new series, No. 944, pp. 197-198, Jan. 31, 1913 (thirteenth meeting).

Vol. 37, new series, No. 952, pp. 498-499, March 28, 1913 fourteenth meeting).

Vol. 37, new series, No. 954, pp. 577-578, April 11, 1913 (fifteenth meeting).

BOOK REVIEWS

THE DIAGNOSIS AND TREATMENT OF TROPICAL DISEASES. E. R. Stitt. 421 pp. 86 illustrations. P. Blakiston's Son & Co., Philadelphia.

This work is more than ordinarily interesting to the parasitologist because of the position and work of the author, who has also written a good text on animal parasitology. The present book emphasizes the clinical aspect of the subject, and is intended as a companion volume to the earlier work. Fortunately, the idea is not carried out rigorously, for in each case a brief statement concerning laboratory diagnosis concludes the discussion of a particular disease.

The classification of diseases which is distinctly modern brings together those due to protozoa and those due to helminthes in two of the chief subdivisions of the text. The discussions of these organisms, while necessarily brief, are in the main very good, as they certainly are complete. The author's style is attractive and his knowledge of the literature in this field unusually broad. In a few cases poor figures were selected, but in general they are adequate, though variable in effect.

FLIES IN RELATION TO DISEASE: Bloodsucking Flies. Edward Hindle. Cambridge University Press. 1914. 8°. 398 pp. 88 figures.

This volume belongs to the Cambridge Public Health Series and is a companion volume to one on Non-Bloodsucking Flies. The introductory chapters discuss clearly and briefly the general problem of the indirect and direct transmission of pathogenic agents, the relation of the definitive and intermediate hosts and their parasites, the external and internal anatomy of adult flies, the anatomy and development of the immature stages and the classification of flies.

The general subject is introduced by a tabulation giving a complete list of the families containing bloodsucking species, a list of the species known to transmit an infective agent, the disease transmitted, their geographical distribution and the authorities responsible for the record. This table is supplemented by another giving the known species of Anophelinae, their present generic location, notes on their habits and connection with malaria. The text contains analytical tables for the identification of the families of Nematocera, Brachycera and Calyptratae, for the identification of the genera and species of Psychodidae and Culicidae, the genera of Muscidae and the species of Glossina.

The families are arranged in their systematic sequence, and under each there is given a detailed discussion with figures of the external and internal anatomy of the adults and immature stages, the habits and development of the immature stages, their enemies and means of combating them. Following the systematic discussion in each case, there is a careful consideration of what is known regarding the various diseases transmitted by bloodsucking flies and their causal organisms, the morphology, life cycle and development, and in many cases maps showing the geographical distribution of the insect carrying the parasite. The chapters dealing with malaria, yellow fever, dengue, filariasis and trypanosomiasis are especially full and to be commended. It is a well-arranged, clearly written, readable volume.

HANDBOOK OF MEDICAL ENTOMOLOGY. By William A. Riley, Ph.D., Professor of Insect Morphology and Parasitology, Cornell University; and O. A. Johannsen, Ph.D., Professor of Biology, Cornell University. Ithaca, N. Y.: The Comstock Publishing Co., 1915. 348 pp.

The appearance of this splendid volume will do much toward placing this country in a leading position in medical entomology, such as it now occupies in other branches of applied entomology. Moreover, the wide distribution which this work is certain to receive doubtless will cause an awakening of interest in

the subject and a recruiting of the workers from the ranks of the entomologists and medical men which should do much to further our altogether too meager knowledge of the relationship of insects and acarines to disease.

While the authors do not profess to have had extended experience in research along these lines, they show a broad acquaintance with the literature of the subject from ancient to modern times, and have exhibited marked skill in assembling in concise form the principal facts recorded by an army of investigators in all parts of the world.

The subject is treated by grouping the matter according to the way Arthropods are connected with the various maladies. It was expressly not the authors' desire to treat all of the diseases known to be carried by Arthropods, but to endeavor to cite a number of the best illustrations of the different methods by which insects act as disease vectors. This has resulted in the omission of some well-established cases in which insects play an important rôle. It is regrettable that more information might not have been given regarding the life history and habits of some of the Arthropods, as the possession of such knowledge lends much to the solution of the problems of insect control, and often suggests the potentialities of an insect or a group of insects in disease transmission.

The style of the authors is interesting, the print good and the illustrations, though largely borrowed, are well chosen and very satisfactorily reproduced. The compactness of the volume is also a desirable factor. Certainly the work will be of wide usefulness.

Some Minute Animal Parasites or Unseen Foes in the Animal World. H. B. Fantham and Annie Porter. 319 pp., 56 figures. Methuen & Co., Ltd., London.

The authors state that the aim of the book is to give a readable account, popular but accurate, of the life histories of some microscopic protozoal organisms that produce disease in higher animals, including man. Emphasis is laid on topics of economic importance: sleeping sickness, malaria, dysentery and kala-azar in man; tstse-fly disease and redwater in cattle; coccidiosis in game and domestic birds; certain fish maladies and insect diseases. The relations of parasites to their environment and to commerce are discussed in certain chapters, so that the needs of students, sportsmen, breeders are met, as well as those of general readers. The task is great and the book modest in size.

After reading it one lays the book aside with mingled feelings of satisfaction and regret; satisfaction that the authors have succeeded so well and regret that more topics are not handled in similar fashion by those who can speak with such authority on the subject treated. Especially in this country is there a dearth of books on the advances of science in definite directions that can be commended to the general reader unfamiliar with the intricate terminology and technicalities of the investigator. Usually either the men who know cannot write, or those who write do not know. But this volume is both accurate and attractive.

The senior author has done much fine work on difficult problems involving the Sporozoa, and the junior author has also demonstrated her grasp on parasitic protozoa, so that it is not surprising to find a masterful treatment of the topic. The work is marvelously complete when one considers the narrow limits of space and the complexity and unfamiliarity of the subject. Unlike most elementary treatises, this one is generous in the citation of authorities, and so far as noted accurate, a virtue conspicuous by its absence in most such books, One feels like applauding this virtue, because it is usually confined to more technical publications, and yet it is the general scientific reader who has most need to hear the names of those who have laid the foundations of the science.

Furthermore, this book reads well. Scientific terms are used sparingly, and when employed are carefully defined. The authors adopted the plan of discussing these organisms from the biologic rather than from the taxonomic standpoint, and while they use with accuracy the scientific names of the various

pathogenic protozoa and group them together in a fashion that accords with proper systematic conceptions, they avoid the introduction of a mass of classificatory subdivisions which impart such a ponderous impressiveness to many texts. The descriptions of the various life histories, which are of such significance in the transmission and prevention of disease, are both vivid and accurate. Even recently elucidated phenomena, such as granule-shedding in spirochetes and in the organism of syphilis, are explained clearly so that the work may be commended for its completeness as well.

The illustrations are rather scanty, perhaps because of the limited space, and some of them are distinctly wooden in being schematic to an unnecessary degree. Or if that feature was retained by choice, then they might have been reduced considerably to make space for other figures. Thus it was surely not necessary to use a full page for a diagram of the bee's alimentary canal; every detail represented would have been equally clear in a cut half the size or even smaller. For an audience of the type to which the book appeals, an abundance of illustrations is indispensable, as the descriptions alone give a vague idea of the appearance of such unfamiliar things. This is the one weak feature in a very successful work; yet despite it the book should be recommended widely and strongly to all seeking knowledge of this new and fascinating field of recent discoveries concerning life and disease.

NOTES

The Preliminary Report of the Institute of Tropical Medicine and Hygiene of Porto Rico summarizes the work done during an expedition to the interior. In sixty working days over 10,000 persons were thoroughly examined. The report contains an interesting table of Diseases due to Animal Parasites.

DISEASES DUE TO ANIMAL PARASITES

	Primary	Secondary	Total
Uncinariasis (Necator americanus)	307	680	987
Ascariasis (Ascaris lumbricoides)	44	555	599
Trichuriasis (Trichuris trichiura)	1	152	153
Strongyloidosis (Strongyloides stercoralis)	.....	10	10
Balantidic Dysentery (Balantidium coli)	1	1	2
Oxyuriasis (Oxyuris vermicularis)	2	1	3
Amebiasis (Entameba histolytica)	3	1	4
Schistosomiasis (Schistosoma mansoni)	206	22	228
Malaria (Plasmodium vivax)	2	.....	2
Malaria (Laverania malariae)	6	.....	6
Filariasis (doubtful) (Filaria bancrofti)	4	1	5
Elephantiasis	.....	1	1
Distomiasis (Fasciola hepatica)	.....	1	1
Flagellate diarrhea, species undetermined	2	.....	2
	578	1,425	2,003
Total diseases treated	1,923	1,991	3,914

In the comment it is stated that in 1904 70 per cent. of cases at Utuado were found infected with hookworm and 90 to 98 per cent. at Mayaguez. The intensity of the infection and of the disease was much less this year. In ten years over 300,000 persons have been treated on government initiative and 200,000 on their own responsibility. Even yet 51 per cent. of all cases examined were found to be infected with hookworm.

Infection with roundworms was heavy beyond comprehension, but with comparatively few serious symptoms. Schistosomiasis was found mostly in persons living near the Vivi and Grand rivers and bathing in them. Only two foci of malaria were found, limited in area. The workers were entirely unable to find microfilaria in any case. The tropical form of ameba was not common at the time of the work.

The International Commission on Zoological Nomenclature has finally reached a decision with regard to the spelling of the scientific name of the European hookworm. This will be welcomed by all. The confusion of some twenty variants which have burdened our recent literature, and the appeals of partisans for their particular type have grown unendurable. Even those who do not like the form chosen must welcome a decision finally. Yet despite some murmurs from outside sources that this form, *Ancylostoma,* was not well chosen,[1] and granted that the German will always spell the name with a *k* and others will follow because it sounds right to them, one may confidently predict the early and general introduction of the new form. It is simple, philologically defensible, and if pronounced after the Latin method, just what every one has used here and abroad. Undoubtedly, the most important end is to secure uniformity and for that some system is demanded.

It is equally clear that the form of ankylostoma will persist as a common name alongside of the technical form, just as the common name trichina is in constant use, though the correct scientific designation is *Trichinella,* or as one speaks of crustacea and a host of other groups which are correctly written in the scientific form with a capital letter. The process of popularizing technical terms has already gone a long ways in medicine, botany, zoology and other fields of science, and with increasing knowledge and interest will go much further in the near future. We shall come to look to authoritative bodies in each field to determine spelling and usage for us, and will adopt the decision of such commissions without discussion when we have put into practice our theory that such bodies know better what should be done than the educated outsider can possibly determine by any investigation.

In the death of von Prowazek on February 17, last, parasitology has suffered an irreparable loss. Like his distinguished predecessor, Schaudinn, and our own Ricketts, he sacrificed his life at an early age in the pursuit of his investigations undertaken in the interest of science and humanity. When typhus broke out in a German prison camp he entered upon a study of the disease and fell a victim to it. As a brilliant thinker, a keen investigator and a voluminous writer he has already exercised a dominant influence on the development of this field of science. By virtue of work which has no limits in country or time and serves all nations for all ages, he was a benefactor of the whole world and will be honored as such.

1. Editorial, Jour. Am. Med. Assn., March 27, 1915, p. 1081.

INDEX TO VOLUME I

The Numbers of Volume I of the JOURNAL OF PARASITOLOGY were mailed as follows:

No. 1. Sept. 19, 1914. No. 3. March 22, 1915.
No. 2. Dec. 18, 1914. No. 4. July 16, 1915.